I. C. 7090 OCTOBER 1939

UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, SECRETARY

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SOME FUNDAMENTALS OF SMOKE ABATEMENT

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BY

J. F. BARKLEY

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

SOME FUNDAMENTALS OF SMOKE ABATEMENT[1]

By J. F. Barkley[2]

Smoke abatement is a subject of which fuel technology, although absolutely essential, is only a part. Its successful accomplishment starts and ends with human factors that must be given thorough consideration; between this "start" and "end" fuel technology is applied. Smoke abatement usually starts from the desire of some person or persons to be free from uncleanness caused by the stack of someone else and ends with the sincere desire of the operator of the fuel-burning equipment to maintain a clean stack.

Although "smoke abatement" has been discussed for many years, it is only recently that the public has been mindful of such expressions as "air pollution" and "air hygiene." The subject has much in common with that of supplying pure water but is more complicated. The public desires pure water, expects pure water, is willing to pay for pure water, and expects to continue to pay for it indefinitely; it is a development of civilization. It is doubtless correct to say, however, that people in general do not yet realize the detriment of air pollution to their well-being or give the question enough serious consideration. This is illustrated by the fact that in city smoke abatement it is the mass of small householders that sins the most and is the hardest to handle. It is rather difficult to assemble a group of people in a room without the air becoming contaminated with smoke. Smoke abatement will lag with the lack of desire for pure air - probably the biggest human factor involved in its accomplishment.

Enough group desire arising in various cities for better air has resulted in development of methods and schemes for attacking the problem. An ordinance must be passed to give authority to the program. Much work has been done on model ordinances; in 1924 a basic ordinance was prepared by a committee of representatives of the American Society of Heating and Ventilating Engineers, the Stoker Manufacturers Association, the American Civic Association, the American Society of Mechanical Engineers, and members at large. This ordinance has probably served as a reference in the development of all principal city smoke ordinances in this country. Its reprint from Mechanical Engineering, American Society of Mechanical Engineers, May 1924, pages 303 to 305, follows:

1/ Paper presented (partly abridged) at the Twenty-fourth Fuel Engineering Conference of Appalachian Coals, Inc., held at Kalamazoo, Mich., Dec. 13, 1938. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7090."

2/ Supervising engineer, Fuel Economy Service, Bureau of Mines.

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Proposed Standard Smoke Ordinance

"AN ORDINANCE regulating the emission of smoke from any chimney, smokestack or other source within the corporate limits of the city of _____, creating a Bureau of Smoke Regulation, constituting its personnel and prescribing penalties for the violation of the provisions thereof.

"Sec. 1. Be it ordained and enacted by the City of _____, in Council assembled, and it is hereby ordained and enacted by the authority of the same, that there is created a Bureau of Smoke Regulation, the chief of which shall be known as _____ 3/.

The Mayor shall appoint a _____ 3/ at a salary not to exceed _____ per annum. The person so appointed shall be an engineer qualified by training and experience in the theory and practice of the construction and operation of steam boilers and furnaces, also in the theory and practice of smoke abatement and prevention.

The _____ 4/ may, upon the recommendation of the _____ 3/ appoint _____ 5/ at a salary not to exceed _____ per annum. The person or persons so appointed shall be engineers, qualified by training and experience in the theory and practice of the construction and operation of steam boilers and furnaces and the firing of furnaces.

The _____ 4/ may appoint such other inspectors and employees in the Bureau of Smoke Regulation as may be necessary for the proper performance of the work of the said Bureau at such salaries as may be fixed by _____ 6/.

The Mayor shall appoint an Advisory Board of _____ engineers, who shall act as advisers on engineering questions to the _____ Bureau of Smoke Regulation. The Advisory Board shall act as a board of appeals as provided in Section 4 of this ordinance. The members shall serve without pay except when acting as a board of appeals, when they shall receive the sum of _____ each per meeting.

"Sec. 2. "Persons" shall be considered as referring to all individuals, partnerships, or associations other than corporations.

"Corporations" shall be considered as including all bodies corporate, joint stock companies or associations, domestic and foreign, their lessees, assignees, trustees, receivers, and other successors in interest having any of the powers or privileges of corporation not possessed by individuals, partnerships, or unincorporated associations.

"Chart" shall be considered as referring to the Ringelmann Smoke Chart as published and used by the Bureau of Mines.

"Stack" shall be defined as including chimneys, smokestacks, structures, and openings, of any kind whatsoever, capable of emitting smoke. Smokestack

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3/ May be "Bureau Chief," "Superintendent," "Smoke Commissioner," or "Chief Smoke Inspector."
4/ The Mayor or other authority designated by him or by the Council.
5/ May be "Deputy" or "Assistant" with any of the designations in 3/.
6/ Usually the Council.

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on locomotive roundhouses shall be deemed parts of locomotives beneath them for the time being.

"Advisory Board" shall be considered as referring to the Board of Engineers appointed by the Mayor to act as advisers on engineering questions to the Bureau Chief, Bureau of Smoke Regulation of the City.

"Sec. 3. The production or emission within the City of smoke, the density or shade of which is equal to or greater than No. 3 of the Ringelmann chart, from any stack, except that of a locomotive or steamboat, for a period or for periods aggregating two (2) minutes or more in any period of fifteen (15) minutes, and the emission of such smoke from any locomotive or steamboat for a period or for periods aggregating one (1) minute or more in any period of eight (8) minutes, is hereby prohibited.

Sec. 4. No person or corporation shall construct, install, reconstruct, alter, or repair any furnace, boiler furnace, stack, or other apparatus connected with stack, unless he or it shall make application in writing to the Bureau of Smoke Regulation on the form furnished by the said bureau, duly sworn to before a notary public or any person authorized to administer oaths, for a permit for such construction, installation, reconstruction, alteration, or repair and in and by such application shall give the plans and specifications, showing the style and dimensions of the furnace, boiler furnace, stack, or other apparatus connected with a stack intended to be used, a description of the building or part thereof in which such furnace, boiler furnace, or other apparatus is located, including the means provided for regulating the temperature of such building or part thereof and ventilating the same, and generally all provisions made for preventing smoke, together with a statement of the kind of fuel proposed to be used and of the operating requirements to be made of the furnace or furnaces referred to therein, and unless such application shall be passed upon by the Bureau of Smoke Regulation, and approved in writing and a permit issued as hereinafter provided; provided, however, that minor or emergency repairs which do not increase the capacity of such furnace, or which do not involve any substantial alteration in such furnace, boiler furnace, stack or other apparatus, and which do not involve any alteration in the method or efficiency of smoke prevention, may be made without a permit.

Any application shall be approved or rejected within ten (10) days after it is filed in the office of the Bureau of Smoke Regulation.

Upon the approval of any application, a copy of which shall be left on file in the office of the Bureau of Smoke Regulation, and upon the payment of the fees hereinafter provided, the Bureau of Smoke Regulation shall issue a permit for the construction, installation, reconstruction, alteration, or repair of such furnace, boiler furnace, stack, or other apparatus.

In the event that any such application is rejected by the _____ _____, 3/ Bureau of Smoke Regulation, the applicant has the right to appeal from his decision to the Advisory Board. Such appeal shall be made in writing to the _____, 3/ Bureau of Smoke Regulation, who shall call a special meeting of the Advisory Board within three (3) days for the consideration of the matter. If a majority of the members of the Advisory Board present shall be of the opinion that the application calls for such construction, installation,

3/ See footnote 3 on page 2.

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reconstruction, alteration, or repair of furnace, boiler furnace, stack, or other apparatus, that there will not under reasonable conditions of operation be produced or emitted from the stack connected therewith such smoke as is herein prohibited, the decision of the _____,3/ Bureau of Smoke Regulation, shall be reversed and the finding of the Advisory Board shall be binding upon the _____,3/ Bureau of Smoke Regulation; otherwise the same shall be confirmed. In which latter case the fees to the Advisory Board are to be paid by appellant, who shall first give bond or make other deposit of funds for the amount of the fees provided for in Section 1 of this ordinance.

"Sec. 5. It shall be unlawful for any engineer, contractor, or other person or corporation to do the work of constructing, installing, reconstructing, altering, or repairing any furnace, boiler furnace, stack, or other apparatus connected with stack, unless the person or corporation for whom such construction, installation, reconstruction, alteration, or repair is being made has proper authority, in the form of a permit, from the Bureau of Smoke Regulation for such work.

"Sec. 6. For examination of an application for a permit for any such construction, installation, reconstruction, alteration, or repair the Bureau of Smoke Regulation shall collect at the time of issuing such permit, for the use of the City, a fee of _____.

The issue and delivery by the Bureau of Smoke Regulation of any such permit shall not be held to exempt the person or corporation to whom the permit has been issued or delivered or who is in possession of the same, or whose application has been approved, from prosecution on account of the production or emissi of smoke hereby prohibited.

"Sec. 7. The _____,3/ Bureau of Smoke Regulation, shall keep in the office of the Bureau of Smoke Regulation all applications made and a complete record thereof, as well as of all permits issued. He shall also keep a record of all smoke observations on all stacks and generally of the work done by the Bureau of Smoke Regulation. All such records shall be open for inspection by the public at all reasonable times. He shall in all matters pertaining to the enforcement of the provisions of this ordinance report direct to _____

"Sec. 8. The _____,3/ Bureau of Smoke Regulation, his deputies, and inspectors shall have the right to enter in the performance of their duties at all reasonable hours, all premises from which smoke is being emitted or has been emitted, and any person who shall, after proper identification, deny admittance to such person or persons or interfere with him or them in the performance of his or their duties shall be liable to a fine not exceeding _____ or undergo an imprisonment in the county jail or workhouse of not more than _____, or both, at the discretion of the committing magistrate or alderman.

"Sec. 9. If any person or corporation shall violate any one or more of the prohibitions or requirements of this ordinance, the _____,3/ Bureau of Smoke Regulation, shall enter suit before any police magistrate or

3/ See footnote 3 on page 2.

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alderman of the City of _____, and upon conviction such person or corporation shall be subject to a fine or penalty not exceeding _____ for each and every violation thereof, and each day's violation shall constitute a separate offense, or undergo an imprisonment in the county jail or workhouse of not more than _____, or both, at the discretion of the committing magistrate or alderman.

Sec. 10. (a) Each power boiler with more than 1,500 square feet of heating surface, using coal as fuel, shall be provided with a mechanical stoker or other device or attachment approved by the Bureau of Smoke Regulation.

Heating surface shall be construed to mean all boiler surfaces in contact with hot gases.

(b) The minimum distance between dead plate and boiler shell for horizontal return tubular boilers shall be not less than the following, according to diameter of boiler:

Diameter of boiler, inches	Distance from dead plate to shell, inches
48 and less	30
54	32
60	34
66	34
72	36
78	38
84	38

In most cases it is desirable to have more than this minimum.

(c) Where it is proposed to use oil or powdered coal as fuel for horizontal return tubular boilers, the height of the boiler shell above the ashpit shall be not less than 60 inches; in most cases more is desirable.

(d) All hand-fired furnaces for stationary boilers carrying more than _____ _____ 1/ pounds steam pressure shall be provided with steam-air jets or other approved method of admitting auxiliary air above the grates.

If steam-air jets are used, there shall be one such jet for each 250 square feet of heating surface or fraction thereof, and the minimum number of steam-air jets shall be three.

(e) Boilers carrying not to exceed _____ 1/ pounds steam pressure shall be provided with openings to admit auxiliary air above the fuel bed, having free air opening of not less than 3 square inches for each square foot of grate surface.

(f) All return-tubular boiler settings, in addition to steam-air jets and auxiliary air openings, shall have such gas-mixing arches, piers, or other devices as are acceptable to the Bureau of Smoke Regulation.

(g) Full extension furnaces shall be used on all stationary hand-fired vertical fire-tube boilers. The arch of the extension furnace must extend 4 feet behind the grate.

(h) Each hand-fired water-tube boiler of the highly inclined or vertical type shall have full extension furnace with an arch extending at least 4 feet back of the grate and firebrick piers or other acceptable construction installed.

1/ This will vary according to location. As a matter of fact, the minimum pressure at which steam-air jets are really effective is about 60 pounds.

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(i) Each chain-grate stoker shall have an ignition arch with minimum length equal to _____ of the length of active grate.

(Note: In the Illinois district it is the judgment of chain-grate engineers that this minimum should be 3/5 and that in no case should the length of arch be less than 5 feet. Further east 2/5 may be sufficient.)

(j) Side inclined and front overfeed stokers installed under vertically baffled boilers may be set with flush front provided the minimum distance from grate surface to heating surface is 7-1/2 feet. If minimum distance is less tha 7-1/2 feet, a full extension furnace, with arch extending 2 feet back of the grate, shall be used.

(k) Where side inclined and front overfeed stokers are installed under horizontal return tubular boilers, full extension settings shall be used.

(l) Portable boilers of the vertical or locomotive type shall use "smokeless fuel, unless such boilers are equipped with approved smoke-preventing devices which will insure "smokeless" operation under normal working conditions.

(m) Low-pressure heating boilers carrying not to exceed _____ 7/ pounds steam pressure and rated 2,000 square feet or more of steam radiation or 3,000 square feet or more of water radiation shall be of a satisfactory "smokeless" type and capable of reducing the amount of smoke produced so as not to exceed the limit set by Section 3.

(n) Low-pressure heating boilers carrying not to exceed _____ 8/ pounds steam pressure and rated below 2,000 square feet of steam radiation or 3,000 square feet of water radiation and hot-air furnaces with more than 9 squa feet of grate surface, if not of a satisfactory "smokeless" type, shall burn on "smokeless" fuel.

(o) All low-pressure boilers shall be provided with openings, to admit auxiliary air above the fuel bed, having a free air opening of not less than 3 square inches for each square foot of grate surface.

(p) The projected grate area of any boiler using coal as fuel shall be not less than 1/60 of the heating surface where stokers are used and 1/45 of the heating surface in hand-fired furnaces.

(q) The area of the breeching in units not exceeding 1,000 horsepower shall be 1/5 of the grate area.

(r) Unless the height of the flue or stack is greater than 150 feet, the breeching must not drop below the horizontal at any point from boiler to stack.

(s) The unrestricted area through the damper on any water-tube boiler shall be not less than 1/5 of the grate area and for horizontal, return-tubular, internally fired Scotch marine or Continental-type boiler shall be not less than 25 percent in excess of the combined inside area of tubes.

(t) All power and heating plants of over 25 horsepower capacity shall be equipped with stack of sufficient height to give a minimum of 0.25 inch draft over the fire in the furnace under normal working conditions.

(u) Kent's formula, $H.P. = 3.33\ E\sqrt{H}$, may be used to determine the size o the stack. For each right-angle bend in the breeching 10 feet shall be added the height so determined.

7/ See footnote 7 on page 5.

8/ May vary in different States. In Pennsylvania for example, the dividing l between high pressure and low pressure is placed at 15 pounds.

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H.P. = rated boiler horsepower,
= square feet of heating surface ÷ 10 for power boilers,
= square feet of direct radiation (rated capacity) ÷ 100 for steam-heating boilers,
= square feet of direct radiation (rated capacity) ÷ 150 for water-heating boilers,
E = effective area of stack in square feet,
= A - 0.6 $\sqrt{A}$, when A = actual area in square feet,
· E + 4 in. = inside dimensions of a square stack,
diameter of
$\sqrt{E}$ + 4 in. = inside diameter of a round stack,
H = height of stack in feet.

(v) The height of the stack shall be at least 30 times its inside dimension en the height does not exceed 65 feet.
(w) No stack to which a "smokeless" boiler (2,000 square feet or more pacity steam radiation or 3,000 square feet or more capacity water radiation) attached shall be less than 50 feet high above the center of the breeching nnection to the stack.
(x) The inside walls of the stack shall be smoketight, vertical, free from fsets, constrictions, or enlargements, and shall have no openings between the eeching and the top of the stack.
(y) The top of the stack shall extend above or be far enough away from any arby building to avoid downdrafts.
(z) The minimum setting heights of boilers shall be those recommended by the oker Manufacturers' Association and the Boiler Manufacturers Association in 22.

c. 11. Any Ordinance or part of Ordinance conflicting with the provisions of is Ordinance shall be, and the same is, hereby repealed, so far as the same fects this Ordinance."

A model smoke-abatement ordinance has been adopted by the Smoke Prevention sociation. It is published in its manual followed by a questionnaire, with swers from some 80 cities, which throws much light on the way such matters are ing handled. The ordinance and questionnaire with a summary of the answers are printed as follows from the manual (1):2/

Model Smoke Abatement Ordinance

"1. There is hereby established a division in the City of _____ be known and designated as the Smoke _____. All employees in said oke _____ shall be appointed according to law and shall be under the pervision and control of the Smoke _____.
The Smoke _____ shall be charged with the inspection and control the installation and maintenance of heating, power, and fuel-burning equipment, e prevention and abatement of smoke, the examination and approval of plans of l heating, power and fuel-burning installations, and of all smoke prevention

2/ The figures underlined in parentheses refer to items in the bibliography at the end of this paper.

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and abatement installations installed or reconstructed in any building, location, or on any premises within the jurisdiction of the City of _____.

"2. The head of the Smoke _____ shall be an engineer qualified by technical training in the theory and practice of heating, power operation, and fuel burning. He shall also be experienced in and thoroughly familiar with the design, construction, and operation of steam boilers and furnaces and in the theory and practice of smoke prevention and abatement.

"3. No new plants nor reconstruction of any existing plants for producing power and heat, nor either of them, nor any new chimney connected with fuel-burning plants, shall be erected or maintained in the City until plans and specifications of the same have been filed in the office of and approved by the Smoke _____ and a permit issued by him for such erection, reconstruction, or maintenance. Plans and specification to be filed with the _____ shall show the amount of work and the amount of heating to be done by such plant and all appurtenances thereto - including all provisions made for the purpose of securing complete combustion of the fuel to be used and for the purpose of preventing smoke; said plans and specifications shall also contain a statement of the kind of fuel proposed to be used, and said plans and specifications shall also show that the room or apartment in which such plant shall be located is provided with doors, windows, air shafts, fans, and other means of ventilation sufficient to prevent the temperature of such room, apartment, basement, or other portions of such building, wherein such steam plant or apparatus is to be used, from rising to a point higher than one hundred and twenty degrees, Fahrenheit, and sufficient also to provide that the atmosphere of any such apartment, wherein such apparatus may be located, may be entirely changed every ten minutes. Upon the approval of such plans and specifications, a duplicate set of which shall be left on file in said office, and upon the payment of the fees as hereinafter provided, the Smoke _____ shall issue a permit for the reconstruction, erection, or maintenance of such plant. The Smoke _____ shall see that the execution of the work permitted is carried out in conformity with the plans and specifications, with special reference to the amount of space used, the size and construction of the chimney or chimneys used, the provision for the prevention of smoke, and the provisions for ventilation and for the proper temperature in the boiler room.

"4. It shall be unlawful for any person to use any new or reconstructed plant for the production and generation of heat and power, or either of them, until he shall have first procured a certificate from the Smoke _____ certifying that the plant is so constructed that it will do the work required and that the plant is so constructed that it will do the work required and that it can be so managed that no dense smoke shall be emitted from the chimney connected with the furnace or fire box.

"5. The emission of dense smoke within the City of _____ from the smoke stack of any locomotive, steamboat, steam tug, steam roller, steam derrick, steam pile-driver, tar kettle, or other similar machine or contrivance or from any open fire or from the smokestack or chimney of any building or premises, excepting for a period of six minutes in any one hour during which the fire box is being cleaned out or a new fire built therein, is hereby declared to be a nuisance and may be summarily abated by the Smoke _____ or by anyone whom he may duly authorize for such purpose. Such abatement may be in addition to the fine hereinafter provided. Any person, firm, or corporation owning, operating, or in charge or control of any locomotive, steamboat, steam

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ug, steam roller, steam derrick, steam pile-driver, tar kettle, or other similar achine or contrivance, or open fire of any building or premises, who shall cause r permit the emission of dense smoke within the city from the smokestack or himney of any such locomotive, steamboat, steam tug, steam roller, steam derrick, team pile-driver, tar kettle, or other similar machine or contrivance, or open ire from the smokestack or chimney of any building or premises so owned, con- rolled, or in charge of him, her, or them, except for a period of six minutes n any one hour during which the fire box is being cleaned out or a new fire eing built therein, shall be deemed guilty of a violation of this section and pon conviction thereof shall be fined not less than _____ dollars or more than _____ for each offense; and each emission of dense smoke violation of the provisions of this section shall constitute a separate ffense for each and every day on which such violation shall continue.

"6. The fee for the inspection of plans and issuing of permits, and for the nspection of furnaces or other fuel-burning apparatus or devices and issuing of ertificate, shall be as follows:

"7. Prosecutions for all violations of this ordinance shall be instituted y the _____ and shall be prosecuted in the name of the City of _____.

The issuance and delivery by the Smoke _____ of any permit or ertificate for the construction or reconstruction, or any permit for the altera- ion or repair, of any plant or chimney connected with a plant shall not be held o exempt any person or corporation to whom any such permit has been issued or livered, or who is in possession of any such permit, from prosecution on ccount of the emission or issuance of dense smoke caused or permitted by any uch person or corporation.

"8. Any person who shall violate any of the provisions of this ordinance hall be fined not less than _____ dollars nor more than _____ ollars for each offense.

"The following questionnaire pertaining to smoke ordinance regulations in effect n cities throughout the United States and Canada was distributed to approximately 0 cities. The purpose of this survey is to obtain information and prepare a igest of ordinance regulations in effect in a representative number of cities o that officials in charge of smoke abatement work will have accurate informa- ion of the methods used.

"It is anticipated that this information will also prove of benefit in miliarizing stoker and boiler manufacturers and others connected with the fuel- rning industry with the regulations governing the installation and operation f such equipment."

QUESTIONNAIRE

me of City _____ State _____

opulation 1930 _____ Area, square miles _____

otal tons coal burned annually in city, all purposes _____

nthracite _____ tons. Bituminous _____ tons. Semibituminous _____ tons.

Under what department is smoke abatement activity conducted?

epartment of _____

itle of officer in charge of smoke abatement _____

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Name of present incumbent _____
Persons engaged in smoke abatement; full time _____ part time _____
What method is employed to notify owners of smoke violations? _____
_____
Is printed information on smoke abatement prepared and distributed by the department? _____
Do inspectors give firing instructions? _____
Underline the method used to determine smoke density.
Ringelmann, umbrascope, or other _____
What smoke density is prohibited? 1, 2, 3, 4, 5, or dense smoke _____
How long a time period are chimneys allowed to emit smoke? _____
Quote ordinance _____
Penalties provided _____
Draw line through any of following, exempt from ordinance provisions.
Railroads - Marine - Stationary - Low-pressure heating - Small apartment buildings - Residences.

Is the emission of any of the following prohibited from chimneys?
Fly ash _____ Soot and dust _____ Fumes _____ Noxious gases _____
What requirements are in effect to prevent discharge of solid matter? _____
_____
Has a dust-fall survey over the city ever been made? _____
For what years is information as to dust-fall survey available? _____
_____
Has the prevailing smoke density of the city ever been determined? _____
Is an Advisory Board of Engineers provided? _____
Give set-up _____
Are new installations and alterations of fuel-burning equipment supervised under Ordinance authority? _____
What fees are charged for permits? _____
Amount of annual appropriation for smoke abatement $_____
Is smoke-indicating equipment required, if so, in what cases? _____
_____
Have specific requirements been established regarding setting height of boiler furnaces, stokers, etc.? _____
Are any local civic associations or societies actively supporting smoke abatement? _____
Are any people regularly employed in auxiliary smoke abatement? If so, by whom
_____
What is the most discouraging phase of local smoke-abatement activity? Underli such if among the following.
Lack of public smoke consciousness. Public indifference. Buck passing. Poor fuel. Lack of proper fuel-burning equipment. Careless operation. Lack of information in proper methods of firing. Lack of enforcement facilities.
What is your own experience not listed above? _____

Summary of Answers to Question, "What is Your Own Experience Not Listed on Foregoing?"

"Officials filling out the questionnaire were asked for any discouraging factors in smoke-prevention practice which were not listed in the preceding tabulation. We present a summary analysis of their reply.

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"Most of them emphasize the troubles arising out of the economic depression, ch as the use of soft coal in furnaces of hard-coal rating; the use of poor ades of fuel by receivers of apartment buildings; and the tendency to assign much work to the janitors or firemen that they cannot give sufficient attenon to their boilers.

"Many spoke of boilers with insufficient combustion space. Several called r ordinances prohibiting the use of poor grades of soft coal. One was handiped by adverse publicity to the effect that "Smoke means prosperity."

"Improper installation for the burning of sawdust making difficult the conol of cinders, too much faith in the smokeless performance of oil burners, and e emission of cinders, soot, and fly ash were set forth as causing especially ublesome problems.

"Some mentioned lack of cooperative effort on the part of authorities of ustrial districts adjoining cities.

"Some complained of lack of authoritative information on methods of conolling emission of solid matter and fumes and noxious gases from chimneys and k of standardization of methods of measuring same.

"A few cities reported that extensive use of natural gas or oil made for an air without problems of smoke prevention."

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Summary compilation of answers to questionnaire on smoke prevention

City	Population[1]	Area, sq.mi.	Tons of coal burned yearly[1]: Total	Anthracite	Bituminous	Semi-bituminous	Coke and oil	Tons per sq.mi.
Akron, Ohio	256	55	500	15	250	235	--	9,09
Albany, N. Y.	152	19	2/300	220	40	--	40	15,78
Asheville, N. C.	52	14	200	--	--	--	--	14,28
Atlanta, Ga.3/	270	34	2/500	--	--	--	--	14,70
Baltimore, Md.	850	92	1,500	500	1,000	--	--	16,30
Birmingham, Ala.	293	52	2/1,000	None	1,000	None	--	19,23
Buffalo, N. Y.	575	42	11,750	1,750	9,000	--	1,000	27,9
Canton, Ohio	110	13	4,950	--	950	4,000	--	38,0
Cedar Rapids, Iowa	57	24	--	--	--	--	--	--
Chattanooga, Tenn.	176	27	2/700	--	4/700	--	--	25,9
Chicago, Ill	3,376	200	5/21,116	350	14,054	5,193	1,518	105,5
Cincinnati, Ohio	425	74	2/3,500	--	--	--	--	47,2
Cleveland, Ohio	1,000	73	--	--	--	--	--	--
Columbus, Ohio	308	39	1,444	--	1,389	55	--	37,0
Covington, Ky.	65	6	--	--	--	--	--	--
Dayton, Ohio	210	24	2/900	--	250	200	--	--
Denver, Colo.	300	59	1,200	None	240	960	--	20,3
Davenport, Iowa	61	18	2/297	--	287	10	--	16,5
Des Moines, Iowa	143	55	--	25	750	125	--	--
Detroit, Mich.	1,650	139	8,000	--	--	--	--	57,5
Duluth, Minn.	101	63	--	--	--	--	--	--
East Cleveland, Ohio	42	3	181	5	76	100	--	60,3
East Orange, N. J.	77	4	--	135	--	--	--	--
Erie, Pa.	120	21	--	--	--	--	--	--
Evanston, Ill.	65	8	--	--	--	--	--	--
Fort Wayne, Ind.	125	18	--	--	--	--	--	--
Flint, Mich.	156	30	--	--	--	--	--	--
Grand Rapids, Mich.	169	23	700	52	193	455	--	30,4
Green Bay, Wis.	37	14	1,389	15	1,030	343	--	99,2
Hamilton, Ohio	52	7	--	--	--	--	--	--
Hamilton, Ontario	154	13	2/1,687	822	803	--	--	12,9
Harrisburg, Pa.	80	2/10	--	--	--	--	--	--
Hartford, Conn.	177	18	--	--	--	--	--	--
Highland Park, Mich.	53	3	--	--	--	--	--	--
Indianapolis, Ind.	417	52	2,300	--	--	--	--	53,8
Kansas City, Mo.	428	60	1,237	100	1,137	--	--	20,6
Knoxville, Tenn.	106	26	800	None	750	--	50	30,7
Lakewood, Ohio	75	6	--	--	--	--	--	--
Lansing, Mich.	78	12	500	350	6/150	--	--	41,6
Lincoln, Nebr.	84	24	--	--	--	--	--	--
Los Angeles, Calif.7/	1,479	400	--	--	--	--	--	--
Louisville, Ky.	328	38	1,621	2	1,581	8	30	42,6
Madison, Wis.	63	9	--	--	--	--	--	--
Milwaukee, Wis.	624	44	4,407	290	2,768	954	394	100,1
Memphis, Tenn.	253	49	--	--	--	--	--	--
Minneapolis, Minn.	477	58	2/1,015	42	973	--	--	17,5
Nashville, Tenn.	160	26	1,000	None	1,000	None	--	38,5
New Bedford, Mass.	110	19	--	--	--	--	--	--
Newark, N. J.	450	23	--	750	--	--	--	--

See footnotes on page 13.

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Summary compilation of answers to questionnaire on smoke prevention - Continued

City	Population[1]	Area, sq. mi.	Tons of coal burned yearly[1]					Tons per sq. mi.
			Total	Anthracite	Bituminous	Semibituminous	Coke and oil	
Orleans, La.	500	196	--	--	--	--	--	--
York, N. Y.	7,434	322	[8]/20,009	10,646	9,140	--	222	62,108
gara Falls, N. Y.	80	15	--	--	--	--	--	--
walk, Conn.	42	26	--	--	--	--	--	--
wood, Ohio	38	4	--	--	--	--	--	--
Park, Ill.	78	1½	--	--	--	--	--	--
ladelphia, Pa.	1,999	130	[2]/3,501	1,811	1,690	--	--	26,930
tsburgh, Pa.	700	54	--	--	--	--	--	--
tland, Oreg.[9]	330	66	--	--	--	--	--	--
vidence, R. I.	253	18	--	--	--	--	--	--
hester, N. Y.	338	34	1,621	[10]/371	[6]/900	--	350	47,676
kford, Ill.	95	12	466	[10]/500	404	--	61	38,833
inaw, Mich.	90	17	248	18	210	20	--	14,588
t Lake City, Utah	140	53	[2]/300	--	300	--	--	--
enectady, N. Y.	99	10	180	150	10	--	20	18,000
ux City, Iowa	80	40	[2]/200	2	180	18	--	5,000
ingfield, Mass.	150	33	--	--	--	--	--	--
Louis, Mo.	840	61	[2]/6,003	[2]/3	5,250	[12]/747	--	98,409
Paul, Minn.	280	56	1,310	10	1,300	--	--	23,392
acuse, N. Y.	200	25	[2]/700	450	250	--	--	28,000
edo, Ohio	348	38	1,750	--	--	--	--	46,052
onto, Ontario	650	34	2,400	625	1,400	375	--	70,588
ca, N. Y.	103	16	--	--	--	--	--	--
couver, British olumbia	259	44	325	--	275	50	--	7,363
hington, D. C.	630	70	1,632	387	[6]/1,245	--	--	23,314
eling, W. Va.	62	7	[2]/100	--	--	--	--	14,285
ipeg, Manitoba	224	25	[2]/522	190	202	125	--	20,880
kers, N. Y.	135	21	--	--	--	--	--	--
ngstown, Ohio	180	33	--	--	--	--	--	--
ke districts - oston and vicinity, Mass.	1,921	291	--	--	--	--	--	--
dson County, N. J. [11]	732	44	3,500	1,000	750	1,750	--	79,945

Thousands.
1936 report.
Oil and coke.
Except railroad.
1933 report.
Includes Semibituminous coal.
Use fuel oil.
1934 report.
Oil, sawdust, and hog fuel.
Tons.
Also 6 million barrels of oil.
From all other fuels.

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Under what department is smoke abatement activity conducted?

City	Department	Title	In charge of smoke abatement
Akron, Ohio	Division Building Inspection Public Safety.	Inspector of Heating and Fuel-Burning Equipment	Norman A. Hixson
Albany, N. Y.	Health, Division Sanitation	Commissioner of Health	Dan V. O'Leary, M.
Asheville, N. C.	Smoke Abatement Division	Smoke Abatement Engineer	Harvey N. Miller
Atlanta, Ga.	Sanitary	Boiler and Smoke Inspector	Andrew W. Jones
Baltimore, Md.	Public Works; Division of Smoke Control	Smoke Abatement Engineer	Luke Ellis
Birmingham, Ala.	Health; Division Sanitation	Director	A. D. Brown
Buffalo, N. Y.	Health	Assistant Chief Inspector	Frank E. Trumble
Canton, Ohio	Public Safety	Chief Smoke Inspector	Samuel Moore
Cedar Rapids, Idaho	Building Inspection	Building Inspector	O. L. Leefers
Chattanooga, Tenn.	Health	Smoke Abatement Engineer	Eugene B. Hyden,
Chicago, Ill.	Smoke Inspection and Abatement	Deputy Smoke Inspector in Charge	Frank A. Chambers
Cincinnati, Ohio	Buildings	Chief Smoke Inspector	Charles W. Gruber
Cleveland, Ohio	Public Safety: Division of Building and Smoke	Commissioner of Building and Smoke	Wm. D. Guion
Columbus, Ohio	Public Safety	Smoke Inspector	A. N. Cope
Covington, Ky.	Health	Sanitary Guard	James C. Reenen
Dayton, Ohio	Service and Building	Smoke Inspector	Howard Yost
Denver, Colo.	Building	do.	Albert G. Reuter
Davenport, Iowa	Construction	Building Inspector	A. S. Bisbee
Des Moines, Iowa	Public Affairs	Chief Smoke Inspector	Richard N. McAlw
Detroit, Mich.	Buildings and Safety Engineers	do.	Chas. J. McCabe
Duluth, Minn.	Health	Chief Food and Sanitary Inspector	E. O. Ericson
East Cleveland, Ohio	Public Safety; Smoke Inspection and Regulation	Smoke Inspector	John A. Cowing
East Orange, N.J.	Health	Health Officer	Frank J. Osborne
Erie, Pa.	Public Safety; Bureau Engineers Licenses and Smoke Abatement	Chief Inspector	John M. Lynch
Evanston, Ill.	Buildings	Commissioner Buildings	E. M. Goodman
Fort Wayne, Ind.	Building	Heating Inspector	Hubert J. Furge

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Under what department is smoke abatement activity conducted?

City	Department	Title	In charge of smoke abatement
nt, Mich.	Public Works and Utilities	Smoke Inspector	Edgar W. Hills
nd Rapids, Mich.	Public Service	do.	Glen M. Jewell
en Bay, Wis.	Building and Police Department	Building Inspector	Albert Manders
ilton, Ohio	Building and Health	do.	F. E. Weaver
ilton, Ontario	Health	Smoke Inspector	John O'Hanley
risburg, Pa.	Public Safety; Bureau Smoke Regulation	Bureau Chief	George W. H. Roberts
tford, Conn.	Building	Building Supervisor	William J. Ennis
hland Park, ch.	Engineering	City Engineer	L. C. Whitsit
ianapolis, Ind.	Bureau of Buildings	Combustion Engineer	J. W. Clinehens
sas City, Mo.	Public Works; Division of Smoke Prevention	Smoke Commissioner	Edward D. McCarty
xville, Tenn.	Public Service	Smoke Abatement Engineer	Art C. Bozeman
ewood, Ohio	Public Safety	Smoke Inspector	Edward C. Sargent
sing, Mich.	Building	Building Commissioner	C. J. Fox
oln, Nebr.	Fire	Fire Chief	Chief Donnelly
Angeles, lif.	Health; Bureau of Housing and Sanitation	Director of Health and Sanitation	Morris S. Siegel
isville, Ky.	Municipal Research and Service	Director	Curtis C. Webb
ison, Wis	Police	Smoke Inspector	Wm. T. Frederick
waukee, Wis.	Safety Engineer, Smoke Abatement, Boiler Inspection	Chief Examiner Superintendent Inspector	Reinhard Kunz
phis, Tenn.	Boiler Inspection	Boiler and Smoke Inspector	Frank A. Heckinger
neapolis, Minn.	Buildings	Smoke and Stoker Inspector	Walter A. Swanson
xville, Tenn.	Smoke Inspection	Smoke Inspector	Wm. Culbert
Bedford, Mass.	Fire	Chief	Edward F. Dahill
ark, N. J.	Parks and Public Property	Smoke Inspector	Wm. B. Schaum
Orleans, La.	Smoke Abatement, Public Safety	Chief Smoke Inspector	James E. Leddy
York, N. Y.	Health	Director Sanitary Bureau	John Oberwager, M. D.
gara Falls, N.Y.	Building	Building Commissioner	Norman Ray
walk, Conn.	Street	City Engineer	Paul J. James
wood, Ohio	Building and Smoke Inspection	Commissioner	Henry B. Burwinkel

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Under what department is smoke abatement activity conducted?

City	Department	Title	In charge of smoke abatement
Oak Park, Ill.	Public Works	Smoke Inspector	Wm. F. Bartels
Philadelphia, Pa.	Public Safety; Bureau of Steam Engineering and Boiler Inspection	Chief Inspector	William Betz, Jr.
Pittsburgh, Pa.	Health	Superintendent, Bureau Inspection	Howard C. Patton
Portland, Oreg.	Public Works, Bureau of Buildings	Smoke Inspector	B. W. Arnold
Providence, R. I.	Public Service Engineers Department	Public Service Engineer	Ralph W. Eaton
Rochester, N. Y.	Public Safety; Bureau of Building, Division Smoke	Smoke Inspector	Ernest B. Brundag
Rockford, Ill.	Public Health	Commissioner Health	N. O. Gunderson, M
Saginaw, Mich.	Public Works, Inspection Division	Chief Inspector	Seth P. Burnett
Salt Lake City, Utah	Streets and Public Improvements	Assistant Engineer	Julius Billeter
Schenectady, N.Y.	Engineering and Public Works	Sanitary Engineer	Morris M. Cohn
Sioux City, Iowa	Building Inspection	City Heating Engineer	Carl J. Roman
Springfield, Mass.	Fire	Smoke Inspector	Capt. L. A. Huntoo
St. Louis, Mo.	Public Safety	Commissioner Smoke Regulation	Raymond R. Tucker
St. Paul, Minn.	Public Utilities	Chief Chemist	R. H. Rockwood
Syracuse, N. Y.	Fire Marshal's Office	Fire Marshal	Charles Wilkes
Toledo, Ohio	Safety; Division of Inspection	Smoke Inspector, Acting	William Geleerd
Toronto, Ontario	Property	Property Commissioner	Graham D. Bland, E
Utica, N. Y.	Fire	Chief Inspector Fire Prevention	L. R. Barry
Vancouver, British Columbia	Engineering	Smoke Inspector	John McGregor
Washington, D. C.	do.	Smoke Regulation Engineer	H. K. Kugel
Wheeling, W. Va.	Building	Building Inspector	W. J. Emmerth
Winnipeg, Manitoba	Health	Smoke and Superintendent Inspector	J. Shepherd
Yonkers, N. Y.	Public Safety; Bureau of Combustibles	Inspector of Combustibles	D. M. Morrissey
Youngstown, Ohio	City Planning Commission	Zoning Engineer	Paul Boucherele
Smoke districts - Boston and vicinity, Mass.	Public Utilities	Director	Michael C. O'Neil
Hudson Co., N. J.	Board of Health and Vital Statistics	Smoke Abatement Engineer	Wm. G. Christy

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Personnel - Methods of notification

- Is printed information on smoke abatement prepared and distributed by the Department?
- Do inspectors give firing instructions?

City	Employees		Notification by -			1	2
	Full	Part	Letter	Phone	Personal		
ron, Ohio.....	0	1	x			No	No
bany, N. Y.....	0	4	x		x	No	No
neville, N. C.....	1	0	x		x	No	Yes
lanta, Ga.....	1	0			x	No	Yes
ltimore, Md.....	4	0	x	x	x	(1/)	Yes
rmingham, Ala.....	0	1	x			No	No
ffalo, N. Y.....	3	0	x		x	Yes	Yes
nton, Ohio.....	1	0			x	Yes	Yes
dar Rapids, Iowa..	0	1	x			No	No
attanooga, Tenn...	1	1	x	x	x	Yes	Yes
icago, Ill.....	43	2/ 21	x	x	x	Yes	Yes
ncinnati, Ohio....	7	0	x			Yes	Yes
eveland, Ohio.....	3	WPA	x			Yes	No
lumbus, Ohio.....	1	0	x	x		Yes	Yes
vington, Ky.....	0	1	x		x	Yes	Yes
yton, Ohio.....	0	1	x		x	Yes	Yes
nver, Colo.....	0	1	x			No	Yes
venport, Iowa.....	0	Yes	x	x	x	No	Yes
s Moines, Iowa....	1	1	x		x	No	Yes
troit, Mich.....	4	0	x			Yes	Yes
luth, Minn.....	0	1			x	(4/)	No
st Cleveland, Ohio	0	1	x			Yes	Yes
st Orange, N. J...	0	4	x			Yes	No
ie, Pa.....	0	1	x		x	(1/)	Yes
anston, Ill.....	1	0	x	x	x	No	Yes
rt Wayne, Ind.....	0	1	x		x	Yes	Yes
int, Mich.....	0	1	x	x	x	(4/)	Yes
and Rapids, Mich..	1	0	x			Yes	Yes
een Bay, Wis.....	0	1	x			Yes	Yes
milton, Ohio.....	0	Yes			x	No	No
milton, Ontario...	1	(3/)				Yes	Yes
rrisburg, Pa.....	1	0	x			No	Yes
rtford, Conn.....	0	1	x			No	Yes
ghland Park, Mich.	0	1	x			No	Yes
dianapolis, Ind...	1	WPA	x	x	x	No	Yes
nsas City, Mo.....	4	0	x			(4/)	No
oxville, Tenn.....	0	1	x			Yes	Yes
kewood, Ohio.....	0	1	x	x		No	Yes
nsing, Mich.....	0	2	x		x	No	No
ncoln, Nebr.....	0	Yes					
s Angeles, Calif..	0	Yes	x		x	No	No

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Personnel - Methods of notification - Continued

1. Is printed information on smoke abatement prepared and distributed by the Department?
2. Do inspectors give firing instructions?

City	Employees		Notification by -			1	2
	Full	Part	Letter	Phone	Personal		
Louisville, Ky.....	2	1	x	x	x	Yes	No
Madison, Wis.....	1	0	x		x	Yes	Yes
Milwaukee, Wis.....	1	5	x	x	x	Yes	Yes
Memphis, Tenn.....	0	5			x	No	Yes
Minneapolis, Minn....	0	1	x	x		No	Yes
Nashville, Tenn.....	2	0	x			Yes	Yes
Newark, N. J.....	1	1	x	x	x	No	Yes
New Bedford, Mass....	1	0	x		x	No	No
New Orleans, La.....	3	3	x		x	Yes	Yes
New York, N. Y.....	0	74			x	No	No
Niagara Falls, N. Y..	0	1	(5/)x			No	No
Norwalk, Conn.....	0	1	x			No	No
Norwood, Ohio.....	0	1			x	No	Yes
Oak Park, Ill.....	0	1	x		x	No	Yes
Philadelphia, Pa.....	0	5	x	x	x	No	(6/
Pittsburgh, Pa.....	2	0	x			Yes	Yes
Portland, Oreg.....	1	0	x	x		No	Yes
Providence, R. I.....	1	1	x			Yes	Yes
Rochester, N. Y.....	1	0	x	x	x	No	Yes
Rockford, Ill.....	0	1	x		x	No	Yes
Saginaw, Mich.....	0	1	x		x	No	Yes
Salt Lake City, Utah.	5	(7/)	x	x	x	Yes	Yes
Schenectady, N. Y....	0	1	x	x	x	No	Yes
Sioux City, Iowa.....	0	1				No	No
Springfield, Mass....	0	1	x			Yes	No
St. Louis, Mo.....	16	WPA	x			Yes	Yes
St. Paul, Minn.....	0	1			x	No	Yes
Syracuse, N. Y.....	1	0			x	Yes	No
Toledo, Ohio.....	0	1	x	x	x	Yes	Yes
Toronto, Ontario.....	4	0	x			No	Yes
Utica, N. Y.....	0	1			x		Yes
Vancouver, British Columbia.....	1	0	x	x	x	No	Yes
Washington, D. C.....	5	0	x			Yes	Yes
Wheeling, W. Va.....	0	1	x	x	x	Yes	Yes
Winnipeg, Manitoba...	0	1	x	x	x	Yes	Yes
Yonkers, N. Y.....	0	3	x			No	No
Youngstown, Ohio.....	1	0	x			No	No
Smoke districts - Boston and vicinity, Mass.....	14	0	x	x		Law	Yes
Hudson County, N. J.	11	0	x			Yes	Yes

1/ Ordinance and rules.
2/ WPA clerks and draftsmen employed on filing project.
3/ All sanitary inspectors assist.
4/ Ordinance.
5/ Or police.
6/ On completion.
7/ Winter only.

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Methods used to determine smoke density

City	Ringelmann	Umbrascope	Others	Density prohibited
n, Ohio.....	-	x	-	4,5
ny, N. Y.1/.....	-	-	-	-
ville, N. C.....	-	-	-	(2/)
nta, Ga.....	x	-	-	3,4,5
timore, Md.....	x	-	-	3,4,5
ingham, Ala.....	x	-	-	3,4,5 & D.S.
alo, N. Y.....	x	-	-	3,4,5
on, Ohio.....	x	-	-	3,4,5
r Rapids, Iowa.....	x	-	-	3,4,5
tanooga, Tenn.....	x	-	-	3,4,5
ago, Ill.....	x	-	-	3,4,5
innati, Ohio.....	-	x	-	3,4,5 & D.S.
eland, Ohio.....	x	-	-	(2/)
mbus, Ohio.....	-	x	-	1,2,3,4,5
ngton, Ky.....	-	-	-	2,3,4,5
on, Ohio.....	x	-	-	3,4,5
er, Colo.....	x	-	-	3,4,5
nport, Iowa.....	x	-	-	3,4,5
Moines, Iowa.....	x	-	-	3,4,5
oit, Mich.....	-	x	-	1,2,3,4,5
th, Minn.....	x	-	-	3,4,5
Cleveland, Ohio...	x	-	-	3,4,5 & D.S.
Orange, N. J.....	x	-	-	3,4,5
, Pa.....	x	-	-	3,4,5
ston, Ill.....	x	-	-	3,4,5
Wayne, Ind.....	-	-	-	(2/)
t, Mich.....	-	-	-	4,5
d Rapids, Mich.....	x	-	-	3,4,5
n Bay, Wis.....	x	-	-	(2/)
lton, Ohio.....	-	-	-	(2/)
lton, Ontario.....	-	x	-	None
isburg, Pa.....	x	-	-	3,4,5
ford, Conn.....	x	-	-	4,5
land Pk., Mich.....	-	x	-	2,3,4,5
anapolis, Ind.....	-	x	-	1,2,3,4,5
as City, Mo.....	x	-	-	2,3,4,5
ville, Tenn.....	x	-	-	3,4,5
wood, Ohio.....	x	-	-	3,4,5
ing, Mich.....	-	x	-	2,3,4,5
oln, Nebr.....	-	-	-	(3/)
Angeles, Calif.....	x	-	-	(4/)
sville, Ky.....	x	x	-	3,4,5
son, Wis.....	x	-	-	3,4,5
waukee, Wis.....	x	-	-	3,4,5
his, Tenn.....	x	-	-	4,5
eapolis, Minn.....	x	-	-	(5/)

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Methods used to determine smoke density - Continued

City	Ringelmann	Umbrascope	Others	Density prohibited
Nashville, Tenn.....	x	x	-	3,4,5
New Bedford, Mass.6/				
Newark, N. J.....	x	-	-	2,3,4,5
New Orleans, La.....	x	-	-	3,4,5
New York, N. Y.....	x	-	-	(2/)
Niagara Falls, N. Y.....	-	-	-	-
Norwalk, Conn.....	x	-	-	2,3,4,5
Norwood, Ohio.....	-	x	-	1,2,3,4,5
Oak Park, Ill.....	-	-	-	(2/)
Philadelphia, Pa.....	-	x	-	1,2,3,4,5
Pittsburgh, Pa.....	x	-	-	3,4,5
Portland, Ore.....	x	-	-	3,4,5
Providence, R. I.....	x	-	-	3,4,5
Rochester, N. Y.....	-	x	(7/)	3,4,5
Rockford, Ill.....	x	-	-	3,4,5
Saginaw, Mich.....	-	-	-	(2/)
Salt Lake City, Utah.....	x	-	-	3,4,5
Schenectady, N. Y.....	x	-	-	3,4,5
Sioux City, Iowa.....	x	-	-	4,5
Springfield, Mass.....	-	-	-	(8/)
St. Louis, Mo.....	x	-	-	3,4,5
St. Paul, Minn.....	x	-	-	3,4,5
Syracuse, N. Y.....	x	-	-	3,4,5
Toledo, Ohio.....	x	-	-	(2/)
Toronto, Ontario.....	x	-	-	3,4,5
Utica, N. Y.....	-	x	-	1,2,3,4,
Vancouver, British Columbia.....	x	-	-	3,4,
Washington, D. C.....	x	-	-	3,4,
Wheeling, W. Va.....	x	-	-	3,4,
Winnipeg, Manitoba.....	x	-	-	3,4,
Yonkers, N. Y.....	x	-	-	3,4,
Youngstown, Ohio.....	-	-	-	-
Smoke districts - Boston and vicinity, Mass.	x	-	-	2,3,4
Hudson County, N. J.....	x	-	-	2,3,4

1/ No ordinance.
2/ Dense smoke.
3/ Where nuisance occurs.
4/ Black smoke.
5/ Unreasonable amount.
6/ No provisions in ordinance.
7/ Own chart.
8/ Dark or dense gray.

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Period during which chimneys are allowed to emit smoke and penalties provided by ordinance for violations

City	Time period	Penalties provided		
		Fine	Imprisonment	Both
ron, Ohio	6 minutes in any 1 hour. Once daily.	$10-$100	--	--
bany, N. Y.	No ordinance. In sanitary code.	--	--	--
eville, N. C.	2 minutes in any 15 minutes.	$25	--	--
lanta, Ga.	12 minutes for building or cleaning fire.	$100	--	--
ltimore, Md.	5 to 10 minutes for starting fire. 3 to 7 minutes for cleaning.	$5-$100	--	--
rmingham, Ala.	30 minutes for new fire. 6 minutes in each consecutive hour.	$1-$100	180 days	x
ffalo, N. Y.	6 minutes in 1 hour constitutes a violation.	$10-$25	--	--
nton, Ohio	2 minutes at any one time. 8 minutes in each hour.	$10-$100	--	--
dar Rapids, Iowa	6 minutes in each hour.	$100	30 days	--
attanooga, Tenn.	1 minute at any one time. 6 minutes in each hour.	$2-$50	--	--
icago, Ill.	The emission of dense smoke except 6 minutes allowed at the time of cleaning or building new fire.	1/ $10-$100	--	--
ncinnati, Ohio	6 minutes during new fire or cleaning period.	$5-$500	--	--
eveland, Ohio	6 minutes in any 1 hour for cleaning or new fire.	$10-$100	--	--
lumbus, Ohio	6 minutes in any 1 hour during fire cleaning or fire building.	$10-$200	--	--
vington, Ky.	3 minutes.	$20-$100	--	--
yton, Ohio	3 minutes or more in any period of 15 m.	--	--	--
nver, Colo.	15 minutes in each hour for cleaning or new fire.	$10-$100	--	--
venport, Iowa	6 minutes in each hour.	(2/)	--	--
s Moines, Iowa	6 minutes in each hour. Locomotives 40 seconds in 5 minutes.	$10-$100	--	--
troit, Mich.	Not to exceed 2 continuous minutes. 20 continuous minutes new fire.	$100-$500	90 days	--
luth, Minn.	20 minutes building fire. 2 minutes in 15 minutes for stationary. 1 minute in 15 minutes for locomotives and steam boats.	$10-$100	10-85 days	x
st Cleveland, Ohio	6 minutes in any 1 hour for cleaning or new.	$25-$400	--	--
st Orange, N. J.	6 minutes in any 1 hour for cleaning or new fire.	$5-$100	--	--
rie, Pa.	2 minutes in 15 or 20 minutes once a day cleaning or new fire.	$25-$100	--	--
vanston, Ill.	6 minutes in any 1 hour.	$10-$100	--	--
rt Wayne, Ind.	6 minutes in any 1 hour.	$5-$100	--	--
lint, Mich.	6 minutes in any 1 hour.	$100	90 days	--
rand Rapids, Mich.	5 minutes in any 1 hour.	$10-$100	90 days	--

See footnotes on page 23.

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Period during which chimneys are allowed to emit smoke and penalties provided by ordinance for violations - Continued

City	Time period	Penalties provided		
		Fine	Imprisonment	Bo
Green Bay, Wis.	3 minutes every 4 hours.	(3/)	--	
Hamilton, Ohio	10 minutes in each hour.	$100	6 months	
Hamilton, Ontario	No specified time. Nuisance prohibited.	(4/)	--	
Harrisburg, Pa.	2 minutes in 15 minutes - 20 minutes in day cleaning or new fire.	$100	90 days	
Hartford, Conn.	9 minutes in any 1 hour.	$50-$100	--	
Highland Park, Mich.	2 minutes in 20 minutes. 20 minutes for new fire once every 24 hours.	$100	90 days	
Indianapolis, Ind.	6 minutes in any 1 hour.	$2-$500	--	
Kansas City, Mo.	5 minutes in any 1 hour for cleaning or fire building.	$10-$50	--	
Knoxville, Tenn.	1 minute in period of 8 minutes. 30 minutes in day for new fire.	$3-$50	--	
Lakewood, Chio	6 minutes in each hour.	$10-$100	--	
Lansing, Mich.	9 minutes in any 1 hour not to exceed 2 consecutive minutes. 20 minutes in hour for new fire.	$50	30 days	
Lincoln, Nebr.	Prohibits nuisance.	$1-$100	--	
Los Angeles, Calif.	3 minutes intermittent or continuous per hour.	5/$500	6 months	
Louisville, Ky.	3 minutes in 30 minutes.	$10-$100	--	
Madison, Wis.	6 minutes in each hour for cleaning or new fire.	$1-$10	--	
Milwaukee, Wis.	5 minutes in any 1 hour.	$25-$200	--	
Memphis, Tenn.	3 minutes in each hour.	$1-$50	--	
Minneapolis, Minn.	Not specified. Unreasonable amount.	$25-$100	90 days	
Nashville, Tenn.	5 minutes.	$25	--	
New Bedford	Not over 5 continuous minutes or more than 90 minutes in any continuous period of 12 hours.	$100	--	
Newark, N. J.	12 minutes of No. 2 in 1 hour; No. 3 - 2 minutes in 15 minute period is violation.	5/$50	30 days	
New Orleans, La.	5 minutes in any hour.	$25	30 days	
New York, N. Y.	Not specified. In sanitary code. Misdemeanor up to	$500	--	
Niagara Falls, N. Y.	8 minutes each hour.	$50	--	
Norwalk, Conn.	4 minutes of No. 2 in 15 minutes. 2 minutes of No. 3 in 15 minutes.	$50	--	
Norwood, Chio	6 minutes in any 1 hour.	$25-$300	10-30 days	
Oak Park, Ill.	6 minutes in any 1 hour.	6/$25	--	
Philadelphia, Pa.	None.	$25	--	
Pittsburgh, Pa.	2 minutes in 15 minutes stationary. 1 minute in 8 minutes locomotive.	Fine	x	

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Period during which chimneys are allowed to emit smoke and penalties provided by ordinance for violations - Continued

City	Time period	Penalties provided		
		Fine	Imprisonment	Both
tland, Oreg.	3 minutes not to exceed 6 minutes total per hour.	$100	30 days	--
vidence, R. I.	6 minutes total in any period of 1 hour. Locomotives, 1 minute in 5 minutes.	--	--	--
hester, N. Y.	5 minutes in 4 hours. Ordinance not in force 5 to 7:30 a.m.	$50	50 days	--
kford, Ill.	6 minutes in any 1 hour.	$10-$100	--	--
inaw, Mich.	30 minutes duration once every 6 hours. Changing fire.	6/$100	--	--
t Lake City, Utah	1 minute in each hour for cleaning or fire cleaning.	$10-$299	6 months	x
enectady, N. Y.	75 seconds in each hour.	$25-$100	--	--
ux City, Iowa	No time limit specified	$10-$100	--	--
ingfield, Mass.	2 minutes of dense gray or dark smoke.	$50	--	--
Louis, Mo.	6 minutes in any 1 hour for cleaning or new fire.	$25-$100	--	--
Paul, Minn.	1 minute in 6 minutes and not more than 6 minutes per hour.	$25-$100	--	--
acuse, N. Y.	6 minutes in any 1 hour for cleaning or new fire.	$100	--	--
edo, Ohio	6 minutes in each hour.	$5-$100	--	--
onto, Ontario	6 minutes in any 1 hour.	5/$50	--	--
ca, N. Y.	3 minutes in 20 minutes - 6 minutes in any hour for cleaning fire.	$25-$50	--	--
couver, British olumbia	2 minutes in 15 minutes.	5/$100	2 months	--
hington, D. C.	No dense smoke.	5/$500	--	--
eling, W. Va.	20 minutes for fire building.	$100	1 year	--
nipeg, Manitoba	No time limit specified.	--	--	--
kers, N. Y.	Discretion of the inspectors.	$200	100 days	x
ngstown, Ohio	Zoning ordinance.	$1-$200	--	--
ke districts - oston and vicinity, Mass.	Stacks are classified and times vary with classes. 7/	$10-$100	--	--
dson County, N. J.	Stationary 2 minutes No. 3 in 15 minutes, 12 minutes No. 2 in 1 hour; railroad and marine - 30 30 seconds No. 3 in 3 minutes, 4 minutes No. 2 in 15 minutes.	$50	30 days	x

Summary abatement.
Yes or abatement of nuisance.
Subject to fine.
Fine provided by laws.
Maximum.
And costs.
See p. 38.

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Are any of the following exempt from smoke ordinance provisions?

City	Railroads	Marine	Stationary	Low-Pressure heating	Small apartments	Homes
Akron, Ohio	-	-	-	-	Yes	Yes
Albany, N. Y.	(1/)	-	-	-	-	-
Asheville, N. C.	Yes	-	-	-	-	-
Atlanta, Ga.	-	-	-	-	-	Yes
Baltimore, Md.	-	-	-	-	-	-
Birmingham, Ala.	-	-	-	-	-	Yes
Buffalo, N. Y.	-	-	-	-	-	-
Canton, Ohio	-	-	-	-	1,2,3	Yes
Cedar Rapids, Iowa	-	-	-	-	-	-
Chattanooga, Tenn.	-	-	-	-	-	-
Chicago, Ill.	-	-	-	-	-	-
Cincinnati, Ohio	-	-	-	-	-	-
Cleveland, Ohio	-	-	-	-	Yes	Yes
Columbus, Ohio	Yes	Yes	-	-	5 or less	Yes
Covington, Ky.	-	Yes	-	-	-	-
Dayton, Ohio	-	-	-	-	-	-
Denver, Colo.	-	-	-	-	Yes	No
Davenport, Iowa	-	-	-	-	-	-
Des Moines, Iowa	-	-	-	-	-	-
Detroit, Mich.	-	(2/)	-	-	(3/)	-
Duluth, Minn.	-	-	-	-	-	-
East Cleveland, Ohio	-	-	-	-	-	-
East Orange, N. J.	-	-	-	-	-	-
Erie, Pa.	-	Yes	-	-	-	-
Evanston, Ill.	-	-	-	-	-	-
Fort Wayne, Ind.	-	-	-	-	-	-
Flint, Mich.	-	-	-	-	-	-
Grand Rapids, Mich.	-	-	-	-	-	-
Green Bay, Wis.	-	-	-	-	-	-
Hamilton, Ohio	-	-	-	-	-	
Hamilton, Ontario	Yes	-	-	-	-	-
Harrisburg, Pa.	Yes	-	-	-	Yes	Ye
Hartford, Conn.	-	-	-	-	Yes	Ye
Highland Park, Mich.	-	-	-	-	-	-
Indianapolis, Ind. 4/	-	-	-	-	-	-
Kansas City, Mo.	Yes	Yes	-	-	-	Ye
Knoxville, Tenn.	-	-	-	-	(5/)	Ye
Lakewood, Ohio	-	-	-	Yes	Yes	Ye
Lansing, Mich.	-	-	-	-	-	-
Lincoln, Nebr.	-	-	-	-	-	-
Los Angeles, Calif.	-	-	-	-	-	-
Louisville, Ky.	-	-	-	-	(6/)	(6
Madison, Wis.	Yes	Yes	Yes	Yes	-	-
Milwaukee, Wis.	-	-	-	-	-	(7
Memphis, Tenn.	-	-	-	-	-	-
Minneapolis, Minn.	-	-	-	-	-	-

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Are any of the following exempt from smoke ordinance provisions? - Continued

City	Railroads	Marine	Stationary	Low-Pressure heating	Small apartments	Homes
ashville, Tenn.....	-	-	-	-	-	Yes
ew Bedford, Mass.....	Yes	Yes	-	-	-	-
ewark, N. J.....	-	-	-	-	-	-
ew Orleans, La.....	-	-	-	-	-	-
ew York, N. Y.....	-	-	-	-	-	-
iagara Falls, N. Y...	-	-	-	-	-	-
orwalk, Conn.....	Yes	Yes	-	-	-	-
orwood, Ohio.....	-	-	-	-	-	-
k Park, Ill.....	-	-	-	-	-	Yes
iladelphia, Pa.....	-	-	-	-	-	-
ttsburgh, Pa.....	-	-	-	-	Yes	Yes
rtland, Oreg.....	Yes	Yes	-	-	-	Yes
ovidence, R. I.....	-	-	-	-	1,2 apts.	Yes
chester, N. Y.....	(8/)	(8/)	(8/)	-	-	-
ckford, Ill.....	-	-	-	-	-	-
ginaw, Mich.....	Yes	Yes	-	-	Yes	Yes
lt Lake City, Utah..	-	-	-	-	(9/)	(9/)
henectady, N. Y.10/.	-	-	-	-	-	-
oux City, Iowa11/...	-	-	-	-	-	Yes
ringfield, Mass.....	-	-	-	-	-	-
. Louis, Mo.....	-	-	-	-	-	-
. Paul, Minn.....	-	-	-	-	Yes	Yes
racuse, N. Y.....	-	-	-	-	-	-
ledo, Ohio.....	-	-	-	-	-	-
ronto, Ontario.....	Yes	Yes	-	-	-	Yes
ica, N. Y.....	-	-	-	-	-	-
ncouver, British olumbia.....	Yes	Yes	-	-	1,2,3 apts.	Yes
shington, D. C.....	-	-	-	-	-	-
eeling, W. Va.....	-	-	-	Yes	Yes	Yes
nnipeg, Manitoba....	-	-	-	-	-	-
nkers, N. Y.....	-	Yes	-	-	-	-
ungstown, Ohio.....	Yes	Yes	Yes	Yes	Yes	Yes
oke districts - Boston and vicinity, Mass.....	-	-	-	-	-	-
dison County, N. J...	-	-	-	-	-	-

No ordinance.
U. S. A. inspection.
All on dense smoke.
Certain types of industrial furnaces.
Building department.
Yes, unless they become a public nuisance.

7/ To a degree.
8/ Allowed 10 minutes to start fires.
9/ Only partially enforced.
10/ Heavy manufacturers in unrestricted zone (as per zoning code).
11/ Council may by resolution exempt brick kilns and other manufacturing plants in outlying sparsely settled districts.

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Is the emission of 1, 2, 3, or 4 prohibited from chimneys?
5. Has a dust-fall survey over the city ever been made?
6. For what years is information on dust-fall surveys available?
7. Has the prevailing smoke density of the city ever been determined?

City	1 Fly ash	2 Soot dust	3 Fumes	4 Noxious gases	5	6	7
Akron, Ohio	Yes	Yes	Yes	Yes	No	-	No
Albany, N. Y.	-	-	-	-	No	-	No
Asheville, N. C.	No	No	No	No	No	-	No
Atlanta, Ga.	Yes	Yes	Yes	Yes	Yes	1927	Yes
Baltimore, Md.	No	No	No	No	No	-	No
Birmingham, Ala.	-	Yes	-	-	No	-	No
Buffalo, N. Y.	Yes	Yes	Yes	Yes	Yes	-	192
Canton, Ohio	Yes	Yes	Yes	Yes	No	-	Yes
Cedar Rapids, Iowa	-	-	-	-	No	-	No
Chattanooga, Tenn.	No	No	No	No	Yes	1938	No
Chicago, Ill.	Yes	Yes	Yes	Yes	Yes	1925-31, 1933-34, 1935-38	Yes
Cincinnati, Ohio	Yes	Yes	Yes	Yes	Yes	1931-39	Yes
Cleveland, Ohio	-	-	Yes	Yes	Yes	1927-28	-
Columbus, Ohio	No	No	No	No	No	-	No
Covington, Ky.	Yes	Yes	Yes	Yes	No	-	No
Dayton, Ohio	-	-	-	-	No	-	No
Denver, Colo.	Yes	Yes	Yes	Yes	No	-	No
Davenport, Iowa	Yes	Yes	Yes	Yes	-	-	-
Des Moines, Iowa	No	No	No	No	Yes	Aug. 1937-Sept. 1938	No
Detroit, Mich.	Yes	Yes	-	-	Yes	1928	Yes
Duluth, Minn.	-	-	-	-	Yes	1935	Yes
East Cleveland, Ohio	-	Yes	Yes	Yes	No	-	No
East Orange, N. J.	Yes	No	No	No	No	No	No
Erie, Pa.	-	-	-	-	No	-	No
Evanston, Ill.	Yes	Yes	Yes	Yes	No	-	No
Fort Wayne, Ind.	-	-	-	-	No	-	No
Flint, Mich.	No	No	No	No	No	-	No
Grand Rapids, Mich.	Yes	Yes	Yes	Yes	No	-	No
Green Bay, Wis.	-	-	-	-	No	-	No
Hamilton, Ohio	(1/)	(1/)	(1/)	(1/)	No	-	No
Hamilton, Ontario	Yes	Yes	Yes	Yes	No	-	No
Harrisburg, Pa.	No	No	No	No	No	-	No
Hartford, Conn.	-	Yes	-	-	No	-	No
Highland Park, Mich.	No	No	No	No	No	-	No
Indianapolis, Ind.	-	-	Yes	Yes	Yes	1933	No
Kansas City, Mo.	-	-	-	-	No	-	No
Knoxville, Tenn.	-	-	-	-	-	-	Yes
Lakewood, Ohio	No	No	No	No	No	-	No
Lansing, Mich.	Yes	-	-	-	No	-	No
Lincoln, Nebr.	-	Yes	-	-	-	-	-
Los Angeles, Calif.	Yes	Yes	-	-	No	-	No
Louisville, Ky.	-	Yes	Yes	Yes	Yes	1936-37	Yes

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Is the emission of 1, 2, 3, or 4 prohibited from chimneys?
5. Has a dust-fall survey over the city ever been made?
6. For what years is information on dust-fall surveys available?
7. Has the prevailing smoke density of the city ever been determined?

City	1 Fly ash	2 Soot dust	3 Fumes	4 Noxious gases	5	6	7
dison, Wis.....	-	Yes	Yes	Yes	No	-	No
lwaukee, Wis.....	Yes	Yes	Yes	Yes	No	-	1917-38
mphis, Tenn.....	No	No	Yes	Yes	Yes	1926	Yes
nneapolis, Minn.....	Yes	Yes	Yes	Yes	Yes	-	No
shville, Tenn.....	No	No	No	No	Yes	1937	No
w Bedford, Mass.....	No	No	No	No	No	-	No
wark, N. J.....	Yes	Yes	Yes	Yes	No	-	No
w Orleans, La.....	Yes	Yes	Yes	Yes	Yes	-	Yes
w York, N. Y.....	Yes	Yes	Yes	Yes	Yes	1936	No
agara Falls, N. Y....	Yes	Yes	Yes	Yes	No	-	No
rwalk, Conn.....	Yes	Yes	Yes	-	No	-	No
rwood, Ohio.....	Yes	Yes	Yes	Yes	No	-	No
k Park, Ill.....	Yes	Yes	Yes	Yes	No	-	No
iladelphia, Pa.....	-	-	-	-	No	-	No
ttsburgh, Pa.....	No	(2/)	No	No	Yes	1912-13, 1923-24, 1929-30	No
rtland, Oreg.....	No	Yes	No	No	No	-	No
ovidence, R. I.....	No	No	No	No	No	-	No
chester, N. Y.....	No	Yes	No	No	Yes	1937-38	No
ckford, Ill.....	-	-	-	-	Yes	1927	No
ginaw, Mich.....	Yes	Yes	Yes	Yes	No	-	No
lt Lake City, Utah...	No	No	No	No	Yes	1919-20	Yes
henectady, N. Y.....	No	No	No	No	No	-	(3/)
ux City, Iowa.....	-	No	No	-	No	-	No
ringfield, Mass.....	No	No	No	No	No	-	No
, Louis, Mo.....	Yes	Yes	Yes	Yes	Yes	Before-1928	Yes
, Paul, Minn.....	No	No	No	No	No	-	No
racuse, N. Y.....	No	No	No	No	No	-	No
edo, Ohio.....	No	No	No	No	No	-	No
onto, Ontario.....	-	-	-	-	-	-	No
ca, N. Y.....	No	No	No	No	No	-	No
couver, British lumbia.....	Yes	Yes	Yes	Yes	No	-	No
shington, D. C.....	Yes	Yes	Yes	Yes	No	-	No
eling, W. Va.....	Yes	Yes	Yes	Yes	-	-	No
nipeg, Manitoba.....	Yes	Yes	Yes	Yes	No	-	No
kers, N. Y.....	Yes	Yes	Yes	Yes	No	-	No
ngstown, Ohio.....	(4/)	(4/)	(4/)	(4/)	No	-	No
ke districts - gston and vicinity, ass.....	No	No	No	No	No	-	No
dson County, N. J..	Yes	No	Yes	No	No	-	No

All permitted within reason.
No. 3 or greater density.
3/ Based on representative stacks.
4/ Zoning ordinance.

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What requirements are in effect to prevent discharge of solid matter?

Akron, Ohio	----------
Albany, N. Y.	----------
Asheville, N. C.	None enforced.
Atlanta, Ga.	None.
Baltimore, Md.	None. Soot, fly ash, and dust can be prevented if discharged with prohibited smoke.
Birmingham, Ala.	None.
Buffalo, N. Y.	Do.
Canton, Ohio	----------
Cedar Rapids, Iowa	None except the General Nuisance Ordinance.
Chattanooga, Tenn.	None.
Chicago, Ill.	Provisions to prevent nuisance from solid matter. Dust collectors, washers, screens, and baffles.
Cincinnati, Ohio	Require proper furnace construction and fly-ash traps.
Cleveland, Ohio	None.
Columbus, Ohio	Do.
Covington, Ky.	----------
Dayton, Ohio	----------
Denver, Colo.	Require cinder arresters on stacks.
Davenport, Iowa	Require screens over the top of stacks.
Des Moines, Iowa	Being considered in new ordinance.
Detroit, Mich.	Require installation of fly-ash collectors.
Duluth, Minn.	None.
East Cleveland, Ohio	Declared a nuisance and may be summarily abated by smoke inspection.
East Orange, N. J.	By steam.
Erie, Pa.	Ordinance No. 4856.
Evanston, Ill.	Require wire guards only.
Fort Wayne, Ind.	----------
Flint, Mich.	None.
Grand Rapids, Mich.	Dust traps, water-washed air filters, and return lines for fly ash and solid matter.
Green Bay, Wis.	None.
Hamilton, Ohio	Do.
Hamilton, Ontario	Screens over chimneys of incinerators and the soot chambers baffled when required. Extracts from bylaws.
Harrisburg, Pa.	None.
Hartford, Conn.	Do.
Highland Park, Mich.	Do.
Indianapolis, Ind.	Do.
Kansas City, Mo.	----------
Knoxville, Tenn.	----------
Lakewood, Ohio	None.
Lansing, Mich.	----------
Lincoln, Nebr.	Ordinance prohibits discharge of soot where nuisance occurs.
Los Angeles, Calif.	Screening of stacks or any other practical method.
Louisville, Ky.	None.
Madison, Wis.	Left to the discretion of the inspector.

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at requirements are in effect to prevent discharge of solid matters? - Continued

lwaukee, Wis.....	Require boiler settings to prevent nuisances.
mphis, Tenn.....	Screens.
neapolis, Minn.....	Shall comply with the standards of good engineering and subject to the approval of the inspector.
shville, Tenn.....	Prohibits nuisance.
Bedford, Mass.....	None.
ark, N. J.....	Do.
Orleans, La.....	Require spray tanks, screens, collectors.
York, N. Y.....	Nuisance is prohibited.
gara Falls, N. Y...	None.
walk, Conn.....	Do.
wood, Ohio.....	Do.
Park, Ill.....	Require a general inspection of all commercial and large buildings.
ladelphia, Pa.....	None.
tsburgh, Pa.....	None except for smoke.
tland, Oreg.....	----------
vidence, R. I.....	None except the law regarding smoke density and duration.
hester, N. Y.....	None in ordinance.
kford, Ill.....	None. Each handled on merits with firm concerned.
inaw, Mich.....	Wire mesh basket at top of stack.
t Lake City, Utah..	None.
x City, Iowa.....	Do.
enectady, N. Y.....	Do.
ingfield, Mass.....	Do.
Louis, Mo.....	Installation of approved and acceptable dust-collecting devices.
Paul, Minn.....	None.
acuse, N. Y.....	Do.
edo, Ohio.....	By amending ordinance No. 2639.
onto, Ontario.....	Require screen for incinerator.
ca, N. Y.....	None.
couver, British lumbia.....	The onus with owner.
hington, D. C.....	None.
eling, W. Va.....	A cage must be erected over each stack or chimney.
nipeg, Manitoba....	None.
kers, N. Y.....	Screens.
ngstown, Pa.....	Can be declared a nuisance by the City Council and Zoning Engineer.
ke districts - oston and vicinity, Mass.....	None.
dison County, N. J.	Acceptable method of collecting fly ash required in new installations of pulverized coal.

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1. Are new installations and alterations of fuel-burning equipment supervised under ordinance authority?
2. What fees are charged for permits?
3. Amount of annual appropriation for smoke abatement?
4. Is smoke-indicating equipment required, if so, in what cases?
5. Have specific requirements been established regarding setting heights?

City	1	2	3	4	5
Akron, Ohio.....	Yes	$3	None	(1/)	Yes
Albany, N. Y.....	(2/)	None	do.	-	Department Buildings
Asheville, N. C.....	Not strictly	do.	do.	No	No
Atlanta, Ga.....	Yes	$1.50	$1,500	No	Yes
Baltimore, Md.....	Yes	3/ $2-$20	$8,600	(4/)	Yes
Birmingham, Ala.....	No	None	None	No	No
Buffalo, N. Y.....	Yes	$1	$10,800	No	Not less than 54 in
Canton, Ohio.....	Yes	(5/)	$1,800	No	Yes
Cedar Rapids, Iowa..	Yes	$1	None	No	No
Chattanooga, Tenn...	Yes	$2-$5	$3,000	No	Yes
Chicago, Ill.....	Yes	6/ $3-$5	$100,640	Where essential	Yes
Cincinnati, Ohio....	Yes	Varies	(7/)	Where essential	Yes
Cleveland, Ohio.....	Yes	$2	$10,200	No	Yes
Columbus, Ohio.....	Yes	$2-$15	$2,850	No	No
Covington, Ky.....	No	None	None	Where essential	-
Dayton, Ohio.....	Yes	Varies with horsepower	None	No	Yes
Denver, Colo.....	Yes	$2 per $1,000 cost	(7/)	No	Yes
Davenport, Iowa.....	Yes	$2	None	Yes	Yes
Des Moines, Iowa....	Yes	$2	$3,000	No	Yes
Detroit, Mich.....	Yes	$2-$15	$10,000	Where essential	Yes
Duluth, Minn.....	Yes	None	(8/)	No	No
East Cleveland, Ohio	Yes	$2	None	No	Not by ordinance
East Orange, N. J...	Yes	Varies	(9/)	No	No
Erie, Pa.....	Yes	$2	$2,532	No	No
Evanston, Ill.....	Yes	10/ $5	(7/)	No	No
Fort Wayne, Ind.....	Yes	10 cents to $1	None	No	Yes
Flint, Mich.....	No	None	-	No	No
Grand Rapids, Mich..	Yes	$1	$2,500	No	No
Green Bay, Wis.....	Yes	$1	$150	No	Yes
Hamilton, Ohio.....	Yes	$1	None	-	No
Hamilton, Ontario...	Yes	Building permit	-	No	Yes
Harrisburg, Pa.....	Yes	$1	-	No	Yes
Hartford, Conn.....	Yes	11/ $4-$5	(7/)	No	No
Highland Park, Mich.	Yes	Oil burner $5	None	No	Yes
Indianapolis, Ind...	Yes	$2-$3	$2,310	No	Yes

See footnotes on page 32
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. What fees are charged for permits?
. Amount of annual appropriation for smoke abatement?
. Is smoke-indicating equipment required, if so, in what cases?
. Have specific requirements been established regarding setting heights?

City	1	2	3	4	5
nsas City, Mo.....	-	$3.50	-	No	-
oxville, Tenn.....	Yes	None	$2,920	-	Yes
kewood, Ohio.....	Yes	$2-$3	Inspector's salary	-	No
nsing, Mich.....	No	-	None	-	-
ncoln, Nebr.....	Yes	$2-$3	do.	-	No
s Angeles, Calif....	Yes	Building permit	do.	No	-
uisville, Ky.....	Yes	None	do.	No	Yes
dison, Wis.....	Oil burner only	-	$175 month	No	No
lwaukee, Wis.....	Rules and regulations	12/ $2	$6,000	Periscopes	Rules and regulations
mphis, Tenn.....	Yes	$3	-	No	Yes
nneapolis, Minn.....	Yes	$2	None	By inspector	No
shville, Tenn.....	Yes	$5	$6,000	No	Yes
w Bedford, Mass.....	State regulations	$1	None	No	State regulation
wark, N. J.....	Yes	Sliding scale	$5,000	Yes, power	Yes
w Orleans, La.....	Yes	$3	$4,000	No	Yes
w York, N. Y.....	No	None	Health budget	No	No
agara Falls, N. Y...	No	do.	None	-	No
rwalk, Conn.....	Yes	$1	do.	-	No
rwood, Ohio.....	Yes	$1-$2, certificate $3	do.	No	No
k Park, Ill.....	No	-	-	No	Yes
iladelphia, Pa.....	Yes	None	None	No	No
ttsburgh, Pa.....	Yes	$2	$12,205	Yes13/	Yes
rtland, Oreg.....	No	-	(7/)	No	No
ovidence, R. I.....	No	-	$2,236	No	No
chester, N. Y.....	No	11/ $1.50	$3500	No	No
chford, Ill.....	No	-	$200	No	No
ginaw, Mich.....	Yes	None	None	No	No
lt Lake City, Utah..	Yes	$2 homes, $5 all other	do.	No	No
henectady, N. Y.....	No	No permits	None	No	No
oux City, Iowa.....	No	No provision	do.	No	No
ringfield, Mass.....	No	-	$35	No	No
. Louis, Mo.....	Yes	$1-$3	$40,000	No	Yes

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4. Is smoke-indicating equipment required, if so, in what cases?
5. Have specific requirements been established regarding setting heights?

City	1	2	3	4	5
St. Paul, Minn.....	No	None	None	No	-
Syracuse, N. Y.....	-	-	-	-	-
Toledo, Ohio.....	Yes	$2-$3	$2,400	No	No
Toronto, Ontario.....	No	None	-	No	No
Utica, N. Y.....	No	do.	None	No	No
Vancouver, British Columbia.....	No	do.	$1,588	When essential	No
Washington, D. C.....	Yes	$3-$25	$15,480	Over 30 horsepower	No
Wheeling, W. Va.....	Yes	$1	(7/)	-	Yes
Winnipeg, Manitoba....	No	None	None	No	No
Yonkers, N. Y.....	Yes	$3 installation	do.	No	No
Youngstown, Ohio.....	No	-	do.	-	No
Smoke districts -					
Boston and vicinity, Mass.....	No	-	$35,200	No	No
Hudson County, N. J.	Yes	$1-$50	$30,000	14/ Yes	Yes

1/ Only in testing density of smoke.
2/ Under permit, Department of Buildings.
3/ Certificate $3 to $30.
4/ All new; 5,000 sq. ft. or more of equivalent radiation.
5/ Rated horsepower, heating surface.
6/ Inspection per unit.
7/ Building Department budget.
8/ Part of Food and Sanitation budget.
9/ In Health and Building budgets.
10/ Per $100 cost of installation.
11/ Per $1,000 cost of installation
12/ Per unit of installation or alteration.
13/ Except where connected load is less than 1,000 sq. ft. radiation.
14/ On all new high-horsepower boilers; steam-heating boilers, 3,000 sq. ft. radiation.

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Is an advisory board of engineers provided?
Are any local civic associations or societies actively supporting smoke abatement?
Are any people regularly employed in auxiliary smoke abatement? By whom?

City	1	2	3
n, Ohio	Yes	No	No.
ny, N. Y.	No	No	No.
ville, N. C.	No	No	No.
nta, Ga.	5 members of sanitary board 4 operating engineers of city plants appointed by council.	Atlanta Smoke Abatement League	No.
imore, Md.	Yes. Advisory and Application Board appointed by mayor	Women's Civic League, Chamber of Commerce, Engineers Club	No.
ingham, Ala.	No	No	No.
alo, N. Y.	No	Yes	No.
on, Ohio	Yes. Members of Smoke Commission	Yes	No.
r Rapids, Iowa	No	No	No.
tanooga, Tenn.	Commission of 5 appointed by mayor.	Yes. Chamber of Commerce, Engineers Club, Garden Clubs, Parent Teachers.	No.
ago, Ill.	Yes. 2 boards - 12 on R.R. Smoke Abatement Hearing Board, Citizen's Advisory Board of 8 engineers.	Municipal Art League, Women's City Club, Association of Commerce, Real Estate Board, General Managers Association.	Railroads and Industries.
innati, Ohio	No	Yes	Smoke Abatement League and Railroad Smoke Inspection Dept., 4 men.
eland, Ohio	No	No	No.
mbus, Ohio	Yes. Commission of 6	Chamber of Commerce	No.
ngton, Ky.	Engineering Examining Board	No	No.
on, Ohio	No	No	No.
er, Colo.	Smoke Commission 5 members	No	No.
nport, Iowa	5 members appointed by mayor with building inspector who is also fire warden.	Yes	No.
Moines, Iowa	3 members, Smoke Abatement Commission.	Yes. Junior Chamber of Commerce, Smoke Abatement League, Women's Federation Clubs.	No.
oit, Mich.	3 engineers.	Yes	No.
th, Minn.	3 qualified engineers	No	No.
Cleveland, Ohio	Consulting mechanical engineer	No	No.

Continued on page 34.

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1. Is an advisory board of engineers provided?
2. Are any local civic associations or societies actively supporting smoke abatement
3. Are any people regularly employed in auxiliary smoke abatement? By whom?

City	1	2	3
East Orange, N. J.	No	No	Health and Buildi Department.
Erie, Pa.	Yes. 3 members.	Yes	No.
Evanston, Ill.	No	Yes	No.
Fort Wayne, Ind.	No	--	No.
Flint, Mich.	No	No	No.
Grand Rapids, Mich.	Yes	No	No.
Green Bay, Wis.	No	Yes. City Beautiful Committee.	No.
Hamilton, Ohio	No	No	No.
Hamilton, Ontario	No	No	No.
Harrisburg, Pa.	No. (We have access to several consulting engineers.)	Yes	No.
Hartford, Conn.	No	No	No.
Highland Park, Mich.	No	No	No.
Indianapolis, Ind.	No	Smoke Abatement League	Smoke Abatement League.
Kansas City, Mo.	No	--	Kansas City Coal Service Institu
Knoxville, Tenn.	Yes 5. 3 mechanical engineers	No	Yes. Smoke and D Abatement Leagu
Lakewood, Ohio	No	No	No.
Lansing, Mich.	Yes. 3-man board.	No	No.
Lincoln, Nebr.	Yes	--	--
Los Angeles, Calif.	No	No	No.
Louisville, Ky.	No	Women's Club, Civic Club, Engineers Association, Railroad and Industries Commission.	
Madison, Wis.	No	No	No.
Milwaukee, Wis.	Yes. Commission of 5	Yes	Yes. 2 railroad smoke inspector
Memphis, Tenn.	No	No	No.
Minneapolis, Minn.	No	No	No.
Nashville, Tenn.	Yes. Commission.	Yes	No.
New Bedford, Mass.	No	No	No.
Newark, N. J.	Yes. 3 consulting mechanical engineers	No	No.
New Orleans, La.	No	No	No.
New York, N. Y.	No	Yes	No.
Niagara Falls, N. Y.	No	No	No.
Norwalk, Conn.	No	No	No.
Norwood, Ohio	No	No	No.
Oak Park, Ill.	No	No	No.

Continued on page 5

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Is an advisory board of engineers provided?
Are any local civic associations or societies actively supporting smoke abatement?
Are any people regularly employed in auxiliary smoke abatement? By whom?

City	1	2	3
ladelphia, Pa.	No	Yes	Yes.
tsburgh, Pa.	Yes. 5 appointed by mayor	Chamber of Commerce and Civic Club	No.
tland, Oreg.	Yes. 5 appointed by mayor	No	No.
vidence, R. I.	No	Yes	Yes. Railroads
ıester, N. Y.	No	No	No.
:ford, Ill.	No	No	No.
inaw, Mich.	No	No	No.
t Lake City, Utah	No	Yes	No.
enectady, N. Y.	No	No	Yes. Fire Department Inspection.
ux City, Iowa	No	No	No.
ingfield, Mass.	No	No	No.
Louis, Mo.	Yes. 5 Appeal Board	No	No.
Paul, Minn.	Yes. 12 appointed by mayor	No	Yes. Railroads.
acuse, N. Y.	--	--	--
edo, Ohio	Yes. Committee of Combustion Engineers	No	No.
onto, Ontario	No	No	No.
a, N. Y.	No	No	No.
couver, British umbia	No	No	No.
ington, D. C.	No	No	No.
eling, W. Va.	No	No	Yes. Boiler dealers
ipeg, Manitoba	No	No	No.
ers, N. Y.	No	No	No.
ngstown, Ohio	No	No	No.
e districts - ston and vicinity, Mass.	No	No	No.
dson County, J. J.	Advisory board of 3 engineers who approve changes in regulations and act as board of appeals on any permit refused.	Yes. Excellent support from various civic organizations.	Yes. Railroads, public utilities, large industrial plants, marine interests.

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What is the most discouraging phase of local smoke-abatement activity? (1) Lack of public smoke consciousness; (2) public indifference; (3) shifting responsibility; (4) poor fuel; (5) lack of proper fuel burning equipment; (6) careless operation; (7) lack of information in proper methods of firing; (8) lack of enforcement facilities:

City	1	2	3	4	5	6	7	8
Akron, Ohio	---	x	---	---	---	---	---	---
Albany, N. Y.	---	---	---	---	x	x	---	---
Asheville, N. C.	x	x	x	x	x	x	x	x
Atlanta, Ga.1/	---	---	---	---	---	x	x	---
Baltimore, Md.	---	---	---	x	x	x	---	---
Birmingham, Ala.	---	---	---	x	x	---	---	x
Buffalo, N. Y.	---	x	x	x	x	x	---	---
Canton, Ohio	x	---	x	x	x	x	---	---
Cedar Rapids, Iowa1/	---	---	---	---	---	x	x	x
Chattanooga, Tenn.	---	x	---	---	x	x	---	x
Chicago, Ill.	---	---	---	x	---	x	---	---
Cincinnati, Ohio	---	---	x	---	x	x	---	---
Cleveland, Ohio	---	---	---	x	x	x	---	x
Columbus, Ohio	---	---	---	---	x	x	x	---
Covington, Ky.	x	x	---	---	---	x	---	---
Dayton, Ohio	---	---	---	x	x	x	---	x
Denver, Colo.	x	x	---	---	x	x	x	x
Davenport, Iowa1/	x	x	x	x	x	x	x	---
Des Moines, Iowa	---	---	x	---	x	x	x	x
Detroit, Mich.	---	---	---	x	x	x	---	x
Duluth, Minn.	x	---	x	---	---	x	x	x
East Cleveland, Ohio	---	---	---	---	---	---	---	---
East Orange, N. J.	---	---	---	x	x	x	---	---
Erie, Pa.	---	---	---	---	---	---	---	---
Evanston, Ill.	---	---	---	x	---	x	x	---
Fort Wayne, Ind.	---	---	---	---	---	---	---	---
Flint, Mich.1/	---	---	x	x	x	x	x	x
Grand Rapids, Mich.	---	---	x	---	---	x	x	---
Green Bay, Wis.	---	---	---	---	x	x	x	---
Hamilton, Ohio1/	---	---	---	x	---	x	x	x
Hamilton, Ontario	---	x	---	---	---	---	---	---
Harrisburg, Pa.	---	---	---	---	---	---	---	---
Hartford, Conn.	---	---	---	x	---	x	x	---
Highland Park, Mich.	---	---	---	x	x	x	---	---
Indianapolis, Ind.	---	---	---	x	x	x	x	---
Kansas City, Mo.	---	---	---	---	---	x	x	---
Knoxville, Tenn.	---	---	---	---	x	x	---	---
Lakewood, Ohio	---	---	---	x	---	x	x	---
Lansing, Mich.	---	---	---	---	---	---	---	---
Lincoln, Nebr.	---	---	---	---	---	---	---	---
Los Angeles, Calif.	---	---	---	---	---	x	x	---
Louisville, Ky.	---	---	---	---	---	x	x	x

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City	1	2	3	4	5	6	7	8
Madison, Wis.	x	x	---	x	x	x	x	---
Milwaukee, Wis.	x	---	x	x	x	---	---	---
Memphis, Tenn.1/	---	---	---	x	---	x	x	---
Minneapolis, Minn.	---	---	---	---	---	---	---	---
Nashville, Tenn.	---	---	---	---	---	---	---	---
New Bedford, Mass.1/	---	---	---	---	---	---	---	---
Newark, N. J.	---	---	---	---	x	---	---	---
New Orleans, La.	---	---	---	x	---	x	---	---
New York, N. Y.	---	---	---	---	x	x	---	---
Niagara Falls, N. Y.	---	x	x	---	---	---	---	---
Norwalk, Conn.	---	---	---	---	---	---	---	---
Norwood, Ohio	---	---	---	---	x	---	---	---
Oak Park, Ill.	x	---	---	x	---	x	x	---
Philadelphia, Pa.	---	---	---	---	---	x	---	x
Pittsburgh, Pa.	---	x	---	---	---	---	---	x
Portland, Oreg.	x	---	---	---	---	x	x	x
Providence, R. I.	---	---	---	---	---	x	---	---
Rochester, N. Y.	---	---	---	---	---	---	---	x
Rockford, Ill.	x	---	---	---	x	x	x	---
Saginaw, Mich.	---	x	---	---	x	x	x	---
Salt Lake City, Utah1/	---	---	---	---	---	---	---	---
Schenectady, N. Y.	x	x	---	---	x	x	x	---
Sioux City, Iowa1/	---	x	x	---	x	x	x	x
Springfield, Mass.	x	---	---	x	x	x	---	---
St. Louis, Mo.	---	---	x	x	x	x	x	---
St. Paul, Minn.	---	---	---	---	---	x	---	---
Syracuse, N. Y.	---	---	---	---	---	---	---	---
Toledo, Ohio	---	---	---	x	x	x	---	x
Toronto, Ontario	---	---	---	---	x	x	---	---
Utica, N. Y.	---	---	---	---	---	x	---	---
Vancouver, British Columbia.	---	---	---	x	x	x	---	---
Washington, D. C.	---	---	---	---	---	x	---	---
Wheeling, W. Va.1/	---	---	---	---	x	x	x	---
Winnipeg, Manitoba1/	---	---	---	---	x	x	x	---
Yonkers, N. Y.1/	x	x	x	x	---	x	---	---
Youngstown, Ohio	---	---	x	---	x	---	---	---
Smoke districts -								
Boston and vicinity, Mass.	---	---	---	x	x	x	x	---
Hudson County, N. J.	---	---	x	---	x	x	---	x

1/ 1936 report.

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COMMONWEALTH OF MASSACHUSETTS

Limiting Time in Which the Emission of Smoke May Be Permitted

Section 2 - As Amended in 1938

"Section 2. The emission of smoke of a degree of darkness or density equal to No. 2 of the chart or greater for more than 6 minutes in any 1 hour from stacks of class I; or of a degree equal to No. 2 of the chart or greater for mo than 6 minutes in any 1 hour but not exceeding during said 6 minutes a degree equal to No. 3 of the chart or greater for more than 3 minutes, from stacks of class II; or of a degree equal to No. 2 of the chart or greater for more than 2 minutes in any 1 hour but not exceeding during said 25 minutes a degree equal t No. 3 of the chart or greater for more than 5 minutes from stacks of class III; or of a degree equal to No. 3 of the chart or greater for more than 3 minutes i any 1 hour from stacks of class IV for more than 5 minutes in any 1 hour from stacks of class V, and for more than 20 seconds in any one period of 5 minutes from stacks of class VI, is hereby prohibited. (See page 23, footnote 7.)"

These ordinances are concerned with "smoke," but its definition is not gi Where smoke abatement is desired, it is important to determine just what nuisa is being considered. Cities that are really active in smoke-abatement work are not satisfied to stop at "small particles of carbon" which is substantially Webster's definition of smoke and would be so accepted in the courts unless oth wise defined. In the past, when hand firing predominated, the carbon particle (easily seen) were considered the nuisance. There was not so much fly ash fro boilers, and such particles were more or less accepted. People did not become particularly excited over sand and dust until the many paved roads caused much it to disappear. Along with road development came the big increase in stoker-fired equipment, which tends to throw out ash rather than carbon particles. O the undesired material coming from a stack, the sulfurous gases are the most damaging, particularly where high-sulfur coals are burned. The tonnage of res ing sulfuric acid released into the air is astounding (2, 3, 4, 5). Every "s ordinance should clearly define its use of the word "smoke," and if the word i not made all-inclusive any other nuisances intended to be considered should be added.

The amount of smoke permitted from a stack by the model ordinances is ba upon its density or relative clearness to blackness, as seen by the eye. For example, a smoke that was 60 percent black would be a gray made by mixing bla and white in proportions of 6 to 4. To establish gray colors on the basis of centage of blackness, the Ringelmann smoke chart was devised. Additional cop of this chart may be obtained free from the Bureau of Mines. From a practica standpoint, it has been found that only four gray colors between clearness an blackness need be used - 20, 40, 60, and 80 percent black as shown in the fig For convenience these colors are numbered 1, 2, 3, and 4; clearness is 0 and percent black is 5. Only a little training is needed to establish these colo in the observer's mind. The chart is hung at eye level, about 50 feet away a about in line with the stack to be observed. The smoke is compared with the different panels of the chart which at 50 feet appear as various shades of g During this training period it is sometimes helpful to have an experienced ob

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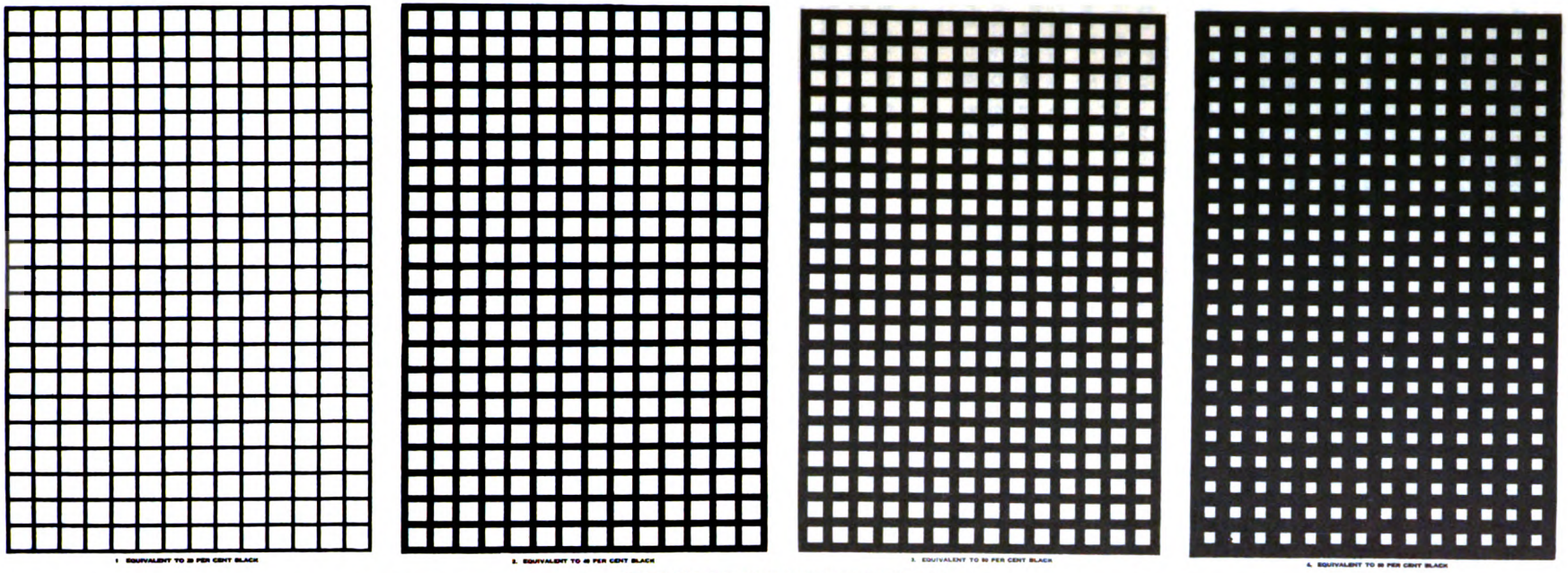
1. EQUIVALENT TO 20 PER CENT BLACK
2. EQUIVALENT TO 40 PER CENT BLACK
3. EQUIVALENT TO 60 PER CENT BLACK
4. EQUIVALENT TO 80 PER CENT BLACK

RINGELMANN'S SCALE FOR GRADING THE DENSITY OF SMOKE.

Hang smoke chart on a level with the eye, about 50 feet from observer, as nearly as possible in line with chimney. Glance from smoke to chart and note corresponding number, recording same and time of observation. Repeat observations at one-fourth or one-half minute intervals. From these records the average density may be determined for each hour, or for each day. No smoke is recorded as No. 0. 100 per cent black smoke is recorded as No. 5. Experienced observers often record in half chart numbers.

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heck with the novice. Complete information as to reading smoke by this method s given in Bureau of Mines Information Circular 6388 (6). After a few trials, n observer learns to read the smoke without the help of the chart, and it is no onger necessary for him to mount it for observation. This scheme of reading moke makes possible not only the determination of when any chosen density of moke is made or exceeded but also the determination of the average smoke produced ver a period of time, which often is of considerable importance.

Many objections have been raised to this method of judging the amount of moke coming from a stack, such as the diameter of the stack, the cloud and wind onditions, and the human element in judging colors, all of which are considered o affect the result. These comments and objections, however accurate, become nconsequential when the entire purpose of the readings is considered. The purpose is not merely to fine some violator because a certain smoke density has been mitted, about which it may be argued just what percentage of blackness occurred r how many black particles were emitted, but the purpose is to lessen smoke mission and to cooperate to the fullest extent in making a cleaner neighborhood. hen a stack gives "dense smoke," as judged by any inspector, work should be done oward improving conditions. The smoke-chart scheme is proving effective and is imple, and none more practical has yet been devised for judging relative blackess.

As shown by the questionnaire answers sent to the Smoke Prevention Association the majority of the cities use the Ringelmann chart for making observations. he definition of "dense" smoke is usually 3 or greater on the Ringelmann chart. ome cities, however, use the umbrascope, which consists of an eyepiece and a ylinder about 4 inches long and 1-1/2 inches in diameter containing clouded lasses hinged to swing in and out of the field of vision and covering half the ircle; through the other half, which is left open, an area of the smoke can be een. By this means the smoke can be compared directly with the clouded glass hich is considered to eliminate some of the human factor in judging grays. The reat disadvantage of this method is its general tediousness and slowness. An bserver cannot be expected to hold the umbrascope to his eye and manipulate glasses ll day long, and his effectiveness in abatement work is greatly lowered because f the relatively few observations that he can make. The observer usually finds hat he can judge the smoke better without the instrument and is tempted to lay t aside. Although a person not actually experienced in smoke reading may feel hat more accuracy can be obtained from direct comparison with a colored glass, sts and experience show differently. The colored-glass schemes might be used n training an observer, and in acute cases where it is necessary to take the iolator to court some might consider the glass comparison as good evidence. oubtless the strongest technical evidence before a court, however, would be a notograph of the smoke at the top of the stack.

It is not so simple to determine how much fly ash is being emitted or to egislate against it. One city considers that the best solution of this difficult roblem is to express a fly-ash limitation on an exact basis - 400 grains per 000 cubic feet of combustion gases. The great difficulty is to determine the ount to an accuracy not open to argument; methods using well-developed schemes f taking samples of the gases require much equipment, skill, time, and expense. ey appear more practical for large installations or for acceptance tests of rge fly-ash-collecting equipment.

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The following is quoted from the New York City building code as published in a paper by Walter L. Fleisher, in Heating, Piping and Air Conditioning, November 1937, page 684:

Discharge of Solids Forbidden:

"Furnaces coming under the provisions of 11.2.1. Combustion Appliances, all rubbish burners and incinerators shall be so designed that under normal conditio of operation they will not discharge smoke, soot, cinders, or fly ash or other residue in such quantities as to cause annoyance to the public or injury to business or property.

Ash and Soot Collectors Required:

"Whenever special considerations make necessary the operation of furnaces which inherently cannot avoid the generation of cinders, fly ash, or soot, the smoke flues serving such furnaces shall be provided with approved cinder catcher or fly-ash and soot collectors, so designed and installed as to be capable of securing the following conditions:

"If coal is used as fuel, the maximum amount of cinders contained in the com bustion gases discharged into the free air shall be 400 grains per 1,000 cu. ft. of combustion gases.

"If powdered or pulverized coal is used as fuel, the maximum amount of fly ash contained in the combustion gases discharged into the free air shall be 400 grains per 1,000 cu. ft. of combustion gases.

"If oil is used as fuel, visible discharge of soot, smoke, or other forms of incomplete combustion is prohibited.

Tests of Amount of Solids Discharged:

"In case of dispute as to whether combustion appliances are meeting the re-quirements of 11.2.2, Discharge of Solids Forbidden, and 11.2.3 Ash and Soot Collectors Required, the Superintendent may require the owner of a structure to have a test made at the owner's expense by a disinterested person acceptable to the Superintendent in order to determine the amount of cinders, soot, and fly a contained in the combustion gases. Tests shall be made as follows:

"To determine the amount of cinders and fly ash contained in the combustion gases, the combustion gases shall be exhausted by a calibrated fan, at points where average results will be obtained, and discharged by the fan through musli or flannel bags of large size and fine weave so as to collect all cinders or fl ash and ascertain the weight thereof.

"The maximum permissible amount of unconsumed carbon in the combustion gase where oil is used as fuel shall be 400 grains per 1,000 cu. ft. of combustion gases determined by a thimble test."

Probably the simplest, most practical scheme to date to determine the amou of fly ash emitted is to weigh, for a chosen period of time, the coal and all refuse or ashes obtainable from the ash pit, any collecting hoppers, any places available on the way to the stack, and the base of the stack. From the ash analysis of the coal and the total coal weight the amount of ash put into the fuel-burning equipment can be calculated. An average ash analysis of all refus and its total weight would give the amount of actual ash caught. The differen in these weights represents the ash that is considered to have gone out the st With this ash went combustible particles that can be assumed to be in about th

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ame ratio, as shown by the analysis of the refuse caught, say, at the base of ne stack. The accuracy of such a method is probably not less than that of other ethods, particularly over a reasonable test period.10/

It is frequently assumed that 90 percent to almost all of the sulfur in the uel goes out the stack (4). A sulfur analysis of the fuel, together with the uel weight, would give this item. Much work remains to be done on sulfur ission.

The ordinance should make possible the issuance of regulations as to design f fuel-burning equipment. At this point the application of fuel technology is eeded. Such regulations should include rules for such items as type of stokers, etting heights, loading, heat releases per cubic foot of combustion space per ur, breechings, stack heights, and smoke indicators. Among good examples of ese regulations are those of Hudson County, N. J., Chicago, Ill., and Washington, . C. These differ somewhat in details. The Rules and Regulations, as issued by e City of Washington, D. C., are given in full; they illustrate the extent and ature of such regulations.

FOREWORD

"This booklet is published for the convenience of citizens who are concerned th the installation of fuel-burning equipment. These rules and regulations are sed on what has been found to be good practice and are designed to afford pro- ction to the owner in securing a satisfactory job and to place manufacturers d contractors on an equal footing. It is not contemplated that they be retro- tive in the sense that the owners of all existing equipment be immediately re- ired to make changes to conform to them.

"It should always be borne in mind that the primary purpose of this Division to secure "smokeless" operation.

H. K. KUGEL,
Smoke Regulation Engineer.

SECTION I. - GENERAL INFORMATION

1. Smoke

"(a) Smoke is the result of the incomplete combustion of any fuel. The imary cause is the failure to secure a sufficient amount of air intimately xed, at the proper temperature, with the combustible gases that are given off the burning of the fuel. The secondary cause is carelessness, ignorance, and difference in the firing and operation of the fuel-burning equipment.

"(b) Smoke can be prevented by -

1. Using a fuel suited to the equipment.
2. Keeping the equipment in good condition.
3. Firing carefully and intelligently.
4. Using automatic fuel-burning equipment wherever possible.

10/ For a more complete discussion on fly ash see Barkley, J. F., Reduction of Fly Ash Emission from Chimneys: Bureau of Mines R.I. 3472, 1939, 10 pp.

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"(c) Smoke is an indication of waste. Prevention results in more uniform heating, a saving in fuel, and consequently reduced costs.

"(d) Smoke has associates which also pollute the air. These include coke (partly burned fuel), ash, and the sulfur gases. Little has been done to minimi them in small installations, but they contribute to the damage and discomfort of living in cities and require serious consideration.

"(e) The Division of Smoke Regulation and Boiler Inspection is glad to advi the public in the proper method of firing as well as the use of proper fuels in the equipment which they have. It hopes for the cooperation of all in its effor to improve conditions in the District of Columbia.

2. Smoke Law

(Public, No. 279, 74th Cong. (S. 2034))

AN ACT To prevent the fouling of the atmosphere in the District of Columbia by smoke and other foreign substances, and for other purposes.

"Be it enacted by the Senate and House of Representatives of the United Stat of America in Congress assembled, That no person shall cause, suffer, or allow dense smoke to be discharged from any building, stationary or locomotive engine, or motor vehicle, place, or premises within the District of Columbia. All pers participating in any violation of this provision, either as proprietors, owners tenants, managers, superintendents, captains, engineers, firemen, or motor-vehicle operators, or otherwise, shall be severally liable therefor. The owner lessees, tenants, occupants, and managers of every building, or place in or upo which a locomotive or stationary engine, furnace, or boiler is used shall cause ashes, cinders, rubbish, dirt, and refuse to be removed to some proper place, s that the same shall not accumulate, nor shall any persons cause, suffer, or all cinders, dust, gas, steam, or offensive or noisome odors to escape or to be dis charged from any such building, or place, to the detriment or annoyance of any person or persons not being therein or thereupon engaged.

"SEC. 2. The Commissioners of the District of Columbia are hereby authoriz and directed to make and promulgate reasonable classifications and regulations for the installation and operation of combustion and all other devices suscepti for use in such manner as to violate the purposes of this Act, and the said Com missioners may from time to time alter, amend, or rescind such regulations and promulgate such amended or additional regulations as they may in their discreti deem necessary.

"SEC. 3. Enforcement of this Act shall be upon information by the Corporat Counsel in the police court of the District of Columbia. Any person convicted violating this Act or any regulation of the Commissioners made hereunder shall punished by a fine not to exceed $500 for each and every such offense.

"SEC. 4. The Commissioners of the District of Columbia shall be responsibl for the enforcement of this Act and may direct the Police Department, the Healt Department, or any officer or employee of the government of the District of Columbia to perform such service as are necessary in connection with such enfor ment. Appropriations are hereby authorized to be made to carry out the purpose of this Act, and the Commissioners of the District of Columbia are authorized t include in their annual estimates provision for the expenses incident to such purposes and for personnel subject to the limitations of the Personnel Classifi cation Act of 1923.

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"SEC. 5. All provisions of the Act approved February 2, 1899 (30 Stat. 812, h. 79, sec. 5), which are inconsistent with this Act are hereby repealed.
Approved, August 15, 1935.

3. Definitions

"(a) Person. - The word "person" signifies and includes firms, corporations, ompanies, receivers, associations, executors, administrators, trustees, uardians, or agents.

"(b) Dense smoke. - The term "dense smoke," as used in section 1 of the Act, hall be defined as smoke equal to or greater than No. 3 of the Ringelmann chart s prepared and approved by the United States Bureau of Mines.

"(c) Cinders, dust, fly ash. - The terms "cinders, dust" as used in section of the Act shall be defined the same as the term "fly ash," which shall be con-idered to be all solids including coke (partly burned fuel), cinders, dust, and oot, formed as a result of the combustion of fuel, which are carried in the gas tream so as to reach the external air.

"(d) Stack. - Stack means any chimney or smokestack or other structure hether of brick, tile, concrete, metal, or other material or a combination of ny of these materials intended for the emission of the products of combustion rom the burning of any fuel or material. Smokestacks commonly known as smoke-acks attached to locomotive roundhouses shall be deemed stacks and a part of hatever locomotive is beneath them for the time being.

"(e) Breeching. - Breeching means any smoke flue or connection leading from boiler or furnace to a stack.

"(f) Horsepower. - Horsepower shall be construed to mean rated boiler horse-ower (hp.) and shall be figured on the basis of 10 square feet of boiler heating urface per horsepower.

"One boiler horsepower shall be considered equal to 140 square feet of quivalent direct steam radiation or 224 square feet of water radiation.

"(g) Boiler-heating surface. - Boiler-heating surface shall be construed to ean all boiler surfaces in contact with hot gases.

"(h) Equivalent direct radiation. - One square foot of equivalent direct adiation (E.d.r.) shall be considered equal to the heat emission of 240 B.t.u. er hour for steam and 150 B.t.u. per hour for hot water.

"(i) Power boiler. - Power boiler shall be construed to mean any boiler arrying over 15 pounds steam pressure.

"(j) Heating boiler. - Heating boiler shall be construed to mean any boiler arrying not over 15 pounds steam or 30 pounds water pressure, or temperatures ot exceeding 250° F.

"(k) Fuel agreement. - A fuel agreement is a written agreement entered into etween the owner of a building or plant and the Division of Smoke Regulation and oiler Inspection whereby the said owner in consideration of a permit being issued or the installation of a certain boiler or furnace agrees to burn only certain pecified fuels.

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SECTION II. - ADMINISTRATION

1. Duties

"(a) The Smoke Regulation Engineer shall be responsible for the administration of the act to prevent the fouling of the atmosphere in the District of Columbia by smoke and other foreign substances, Public, No. 279, Seventy-fourth Congress, approved August 15, 1935, and these regulations issued thereunder.

"(b) He shall issue all permits, certificates, and notices under these regulations; keep applications, permits, plans, violations, complaints, and other records on file for such period as is deemed necessary or as may be directed by the Commissioners of the District of Columbia.

"(c) He shall examine the plans of all new buildings, stacks, and incinerat and plans for the alteration of existing buildings in order to insure that they are in accordance with these regulations.

"(d) He shall also examine the application and plans for the construction, installation, reconstruction, alteration, or repair of any boiler, furnace, incinerator, stack, or other apparatus connected with the stack and, subject to th requirements of these rules and regulations, issue an installation permit.

"(e) The smoke inspectors, when so directed, shall investigate complaints and make inspections and observations of smoke conditions in the District of Columbia. They shall inspect the installation of all equipment for which a permit has been issued and see that the work is done in accordance with regulations and the plans as approved. They shall make daily written reports of all inspections, violations, and complaints.

"(f) Any member of the staff of the Smoke Regulation Engineer shall be authorized to perform such other duties as may be assigned by the said engineer or by the Commissioners of the District of Columbia.

2. Additional Requirements for Obtaining Building Permits

"(a) When application is made and plans are filed with the inspector of buildings for a permit for the erection of a new building, stack, or incinerato or the alteration of an existing building, the application and plans shall be submitted to the Smoke Regulation Engineer, together with a plan and elevation duplicate showing the location of the stack or stacks in reference to adjoining buildings. The plans and application shall be certified in writing by the Smok Regulation Engineer before a building permit is issued.

"(b) Such approval shall not be construed to indicate approval of the structural design of any structure or of any of the requirements of other codes of the District of Columbia.

3. Application for Installation Permits and Certificates of Inspection

"(a) No person shall construct, install, reconstruct, alter, or repair an boiler, water heater, furnace, oven, stoker, oil burner, gas burner, apparatus burn pulverized coal, or other apparatus connected with the boiler, breeching, stack, or any apparatus which may cause dense smoke, cinders, dust, gas, steam, or offensive or noisome odors to be discharged into the air, or make changes or additions to the heating system, domestic hot-water load, process work, or oth load whereby the load on the boiler is materially increased, until he shall hav

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ade application and obtained an Installation Permit from the Smoke Regulation ngineer. The application shall be made out on the form provided, showing the ature of the work to be done, the size and make of the boiler or other equipment, he size and make of the burner or stoker, the fuel to be used, the size of the reeching and stack, and other information pertinent to the installation. Repairs hich do not increase the capacity of such boiler or furnace or do not involve ny alteration or addition to such boiler, furnace, or other apparatus, or which o not involve any alteration in the method of smoke prevention may be made with- ut a permit. Applications for an installation permit for any boiler, furnace, ncinerator, stack, or other apparatus connected with the stack for use in a rivate residence shall not be required until further notice.

"(b) Applications must be accompanied by a sketch or drawing in duplicate howing the location of the boiler in the boiler room with the distance from the a ious walls and exits, the size and location of openings for admission of air o boiler room, the size and location of breeching including damper and clean-out o ors, and the method of installation of stoker, oil burner, or other equipment.

"(c) Upon the approval of any application and the payment of the proper fees o the collector of taxes the Division of Smoke Regulation and Boiler Inspection hall issue an installation permit for the work shown on the application.

"(d) The Smoke Regulation Engineer, or one of his inspectors, shall inspect, fter completion, all boilers, furnaces, stacks, or other apparatus for which an nstallation permit has been issued, and if such be found to be in accordance ith the plans and specifications and the information given on the application a ertificate of inspection shall be issued.

"(e) No person shall use or cause to be used any new, remodeled, or recon- tructed boiler, furnace, incinerator, stack, or other apparatus connected with he stack, unless said person shall have a certificate of inspection, showing hat the construction or reconstruction is in compliance with the plans and pecifications submitted when making application for an installation permit.

"(f) The issuance by the Smoke Regulation Engineer of any installation permit r certificate of inspection for the construction, installation, reconstruction, lteration, or repair of any boiler, furnace, incinerator, stack, or other appara- us connected with the stack shall not be held or construed to exempt any person o whom such installation permit or certificate of inspection may have been ssued from prosecution on account of the emission of smoke and the products of ombustion which are prohibited.

"(g) The Smoke Regulation Engineer and his assistants shall have the right o enter, in the performance of his or their duties, at all reasonable hours, all remises from which smoke, cinders, dust, gas, or odors are being emitted or have een emitted, or where the construction, installation, reconstruction, alteration, r repair of any boiler, furnace, incinerator, stack, or other apparatus connected ith the stack is taking or has taken place, and it shall be unlawful for any erson to deny admittance to said engineer or his assistants or to interfere with im or them in the performance of his or their duties.

"(h) The application for and subsequent issuance of an installation permit by he Smoke Regulation Engineer shall not be construed to indicate approval of the trength or safety of any building or stack or of any of the requirements of the odes which are enforced by the building, plumbing, or electrical inspectors or he fire marshal, nor shall it relieve anyone from the necessity of obtaining a ermit for work covered by these divisions.

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"(i) Fees, as hereinafter provided, shall be paid to the collector of taxes of the District of Columbia and a receipt presented to the Division of Smoke Regulation and Boiler Inspection. Fee for installation permit and certificate of inspection shall be paid at the same time. Fees for heating boilers shall be based on equivalent direct radiation capacity.

FEES

Fees for the installation of boilers, furnaces, and water heaters

	Permit	Certificate
Heating boilers, each:		
Less than 1,200 square feet of steam or 1,800 square feet of water	$1.00	$2.00
1,200 to 5,000 square feet of steam, 1,800 to 7,500 square feet of water	2.00	3.00
5,001 to 25,000 square feet of steam	4.00	6.00
Over 25,000 square feet of steam	6.00	9.00
Boilers when installed in each unit of an apartment building, each	.50	.50
Power boilers, each:		
Less than 50 horsepower	2.00	3.00
51 to 250 horsepower	4.00	6.00
251 to 500 horsepower	8.00	12.00
501 to 1,000 horsepower	12.00	18.00
Over 1,000 horsepower	20.00	30.00
Warm-air furnaces, each:		
Fire pot less than 30 inches in diameter	1.00	2.00
Fire pot 30 inches in diameter or larger	2.00	3.00
Water heaters, each:		
100 to 1,000 gallons	1.00	1.00
Over 1,000 gallons	2.00	3.00
Unclassified apparatus	2.00	3.00

Fees for installation of stokers, oil burners, gas burners, etc., when installed in existing equipment

	Permit	Certificate
Heating boilers, each:		
Less than 1,200 square feet of steam or 1,800 square feet of water	$1.00	$2
1,200 to 5,000 square feet of steam, 1,800 to 7,500 square feet of water	2.00	3
5,001 to 25,000 square feet of steam	4.00	6
Over 25,000 square feet of steam	6.00	9
Power boilers, each:		
Less than 50 horsepower	1.00	2
51 to 250 horsepower	2.00	3
251 to 500 horsepower	4.00	6
501 to 1,000 horsepower	6.00	9
Over 1,000 horsepower	10.00	15

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Fees for installation of stokers, oil burners, gas burners, etc., when installed in existing equipment - Continued

	Permit	Certificate
m-air furnaces, each:		
Fire pot less than 30 inches in diameter	$1.00	$2.00
Fire pot 30 inches in diameter or larger	2.00	3.00
ter heaters, each:		
100 to 1,000 gallons	1.00	1.00
Over 1,000 gallons	2.00	3.00
scellaneous equipment: The installation of steam-air jets, lowers, draft controls, apparatus for collection of fly-ash, etc., which affects the operation of the boilers	1.00	2.00
ler furnaces: Rebuilding or changing boiler furnace or ating system involving a major change in capacity or bustion space	1.00	2.00

"(j) Permits shall be valid and in force for a period not exceeding 6 months, ept that work started within this time and continuously under construction for e than 6 months may proceed to completion under authority of the original permit.

"(k) A permit to install or relocate any boiler, furnace, stack, incinerator, other apparatus connected with the stack shall be issued only after the inc tor of buildings has permitted installation or relocation of such equipment.

"(l) If the work called for in the installation permit shall be conducted in lation of any of the provisions of these regulations or in any other manner n shown on the original plan and application the Smoke Regulation Engineer ll give notice of such violation to the contractor, his foreman, or representae on the job, through one of the smoke inspectors. Such notice shall fix a e which is reasonable and sufficient in the opinion of the Smoke Regulation ineer to make the necessary changes, and if such work is not put in conformity h the regulations within the time mentioned, then he shall revoke the permit. ore such a permit can be lawfully reissued the contractor or owner shall have nged the work so that it conforms to the original plan.

SECTION III. - REQUIREMENTS WHEN PLANS FOR NEW BUILDINGS ARE BEING SUBMITTED

"1. The stack must be of sufficient height and cross-sectional area to pro- e the necessary draft for the proper operation of the boiler and shall comply h all requirements of the building code.

"2. The top of the stack must be of such a height in relation to adjoining ldings so that the gases discharged will not become a nuisance to adjacent ldings and so that down drafts will be prevented.

"3. A clean-out door must be provided at the base of stack.

"4. The stack must be so located in reference to the boiler as to permit of ell-designed breeching of adequate area and having a minimum number of bends turns and with the shortest practicable length.

"5. The boiler room must be of sufficient height to allow for the installa- of boilers of sufficient capacity to carry the full required load and having e combustion space in the boiler furnace. Sufficient headroom must be pro- d for installation of a breeching of proper design and to allow for accessi- ty to manholes and valves connected to boiler.

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"6. Sufficient floor space must be provided to allow for the proper operation of the boiler, including the use of shovel and firing tools, removal of boiler tubes and making necessary repairs, cleaning boiler tubes, furnace firebox, and combustion chambers and to allow for easy access to furnace doors and other openings in and about walls of boiler settings or furnaces and for cleaning and removal of soot and ash from the breeching and stack.

"7. Sufficient exits, properly located, must be provided to allow egress in case of emergency.

"8. The fuel-storage space shall be partitioned off from the boiler room proper and be so located as not to interfere with the efficient operation of the boiler. Where a different kind of coal is required for a hot-water heater, provision must be made for separate storage. Consideration must be given to having satisfactory place for delivering coal and removing ashes from the building so that dirt and dust may be kept to a minimum.

"9. Provision must be made to permit the unrestricted admission to the boil room of a sufficient amount of air to secure smokeless combustion of the fuel an properly to ventilate the room in which the fuel-burning equipment is located.

"10. Incinerators to be used in connection with the new building must be provided with a separate stack and be built in conformity with the incinerator code.

SECTION IV. - REQUIREMENTS BOILER- AND FUEL-BURNING EQUIPMENT

1. General

"(a) Power boilers shall be equipped with underfeed stoker, apparatus to burn pulverized coal, oil burner, or gas burner, which in any case shall be approved by the Division of Smoke Regulation and Boiler Inspection, unless owner of building or plant enters into a Fuel Agreement. No such agreement shall be made for boilers having more than 250 square feet of heating surface.

"(b) Heating boilers having an equivalent direct radiation rating of more than 1,200 square feet of steam radiation or 1,800 square feet of water radiatio shall be equipped with underfeed stoker, apparatus to burn pulverized coal, oil burner, or gas burner, which in any case shall be approved by the Division of Smoke Regulation and Boiler Inspection, unless owner of building or plant enters into a fuel agreement. No such agreement shall be made for boilers having more than 5,000 square feet of steam radiation or the equivalent.

"(c) Heating boilers having an equivalent direct radiation rating of less than 1,200 square feet of steam radiation, or of 1,800 square feet of water radiation, shall burn coke, anthracite, or shall be equipped with underfeed stoker, burner, or gas burner approved by the Division of Smoke Regulation and Boiler Inspection.

"(d) Low-pressure steam boilers, when mechanically fired, shall be equipped with a low-water cut-off, or similar arrangement, so located as to automatically cut off the fuel supply in case the water level falls to a point not lower than the bottom of the water glass. The water-gage glass shall be set as follows: Steel heating boilers of the fire-tube type, the lowest permissible water level shall be (a) for single-pass type the same as called for in paragraph 291 of the power-boiler regulations, (b) for multipass types the top row of tubes shall be completely submerged when the water is at the lowest reading in the water-gage

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glass. All of the water connections shall be nonferrous pipe and fittings with a cross at each right-angle turn.

"(e) Gravity-feed magazine boilers designed exclusively for the burning of coke or anthracite may be installed in all sizes, subject to the requirements and approval of the Division of Smoke Regulation and Boiler Inspection.

"(f) Every boiler shall be constructed and installed in accordance with the provisions of these regulations, the Boiler Inspection Regulations of the District of Columbia where they apply, and the Boiler Code of the American Society of Mechanical Engineers, Section I to VII, inclusive, and Amendments and Interpretations thereto, made and approved by the Council of the Society to date. Every boiler shall bear the A. S. M. E. symbol and number, and the manufacturer's data report form shall be provided when requested.

2. Stokers

"(a) Underfeed stokers shall have minimum furnace heights as follows:

Heating - square feet steam radiation	1,200 to 2,499	2,500 to 6,999	7,000 to 10,999	11,000 to 13,999	14,000 to 17,499	17,500 to 20,999	21,000 to 25,000
Equivalent horsepower	10-18	19-50	51-80	81-100	101-125	126-150	151-175
	Inches	Inches	Inches	Inches	Inches	Inches	Inches
Compact type	36	42	48	54	60	66	72
L. F. B. type	48	54	60	66	72	78	84
H. R. T.	---	42	48	54	60	66	72
Cast iron	36	42	48	54	60	66	---

Abbreviations: L. F. B. = locomotive firebox; H. R. T. = horizontal return tubular.

NOTE. - In using above table, take rated boiler horsepower or radiation, whichever is the larger.

"(b) All dimensions are from the stoker dead plate (or dump grate) to the crown sheet (or equivalent) of the boiler. On down-draft boilers the water grates shall be considered the equivalent of the crown sheet, unless they are removed.

"(c) The above figures are considered to be minimum dimensions and shall be increased wherever the boiler is to carry an overload or has peak-load conditions to be met.

"(d) Stokers designed for anthracite will be given special ruling.

"(e) Horizontal-water-tube heating boilers in sizes up to 25,000 square feet of steam radiation shall, when horizontally baffled, have the same setting heights as compact-type boilers; when vertically baffled they shall have the same setting heights as locomotive firebox-type boilers. For boilers above 25,000 square feet use table below.

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"(f) The minimum furnace heights of all other types and sizes of water-tube boilers equipped with underfeed stokers, to be operated up to 150 percent rating, shall be as follows:

Measurement of setting height	Type of boiler	Multiple retort				Single retort			
		Min.		Pref. min.		Min.		Pref. min.	
		Ft.	in.	Ft.	in.	Ft.	in.	Ft.	in.
Floor line to bottom of header above stoker.	Horizontal, all sizes	11	0	13	0	9	0	11	0
Floor line to center of mud drum.	Incl. H. M. D., all sizes	7	6	8	6	6	6	8	6
Floor line to top of mud drum.	Incl. V. M. D., all sizes	6	0	7	0	5	0	7	0
Floor line to center of mud drum.	Vert. H. M. D., all sizes	3	6	5	0	3	6	5	0
Floor line to top of mud drum.	Vert. V. M. D., 150 hp.	4	6	5	0	4	6	5	0
Do.	Vert. V. M. D., 250 hp.	5	6	6	0	5	6	6	0
Do.	Vert. V. M. D., 500 hp.	6	0	6	6	6	0	6	6

Abbreviations: Incl. = inclined; vert. = vertical; H. M. D. = horizontal mud drum; V. M. D. = vertical mud drum; min. = absolute minimum; Pref. min. = preferred minimum, that is, the heights recommended.

"(g) For power boilers equipped with underfeed stokers, to be operated at more than 150 percent rating, special ruling shall be obtained from the Division of Smoke Regulation and Boiler Inspection. Design of all stoker installations shall be submitted to the Division of Smoke Regulation and Boiler Inspection for approval.

"(h) Stokers shall be installed so that the bottom of the boiler water leg will be suitable protected. Boiler doors shall be of sufficient size and so located that ash and clinker can be easily removed without disturbing the fuel b

"(i) On all stoker installations a clean-out door shall be provided in the breeching and at the base of the stack and an accessible damper in the breechin fitted with a handle and quadrant, or the equivalent, so arranged that it can b clamped in position and be conveniently operated.

"(j) When stokers are rated in terms of coal fed per hour or square feet o equivalent direct steam radiation (E. D. R.), such rating shall be based on nut and slack coal with a heat content taken as not greater than 14,000 B. t. u. pe pound for bituminous coal and 12,400 B. t. u. for buckwheat anthracite, with a combined boiler and stoker efficiency of not to exceed sixty (60) percent for stoker capacities up to seventy-five (75) pounds of coal per hour and not to ex ceed sixty-five (65) percent for stoker capacities over seventy-five (75) pound per hour.

" A certified rating sheet based on the above together with all other necess information shall be supplied for every stoker, subject to the approval of the Smoke Regulation Engineer.

" An allowance of not less than thirty-five (35) percent shall be provided f piping and pick-up.

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"(k) The rating of any stoker shall not be less than the rating of the oiler with which it is to be installed, except that where the boiler is to be perated in excess of its rating the stoker shall be of sufficient capacity dequately to carry such overrating.

3. Pulverized Coal

"(a) When pulverized coal is to be used as fuel, the required combustion pace for all boilers up to 500 horsepower and having refractory walls shall be etermined on the basis of a maximum heat liberation of 20,000 B. t. u. per cubic oot of combustion space per hour. For larger boilers and other types of walls, aximum heat liberation shall be determined for each individual case. An ceptable method of collecting fly ash from the stacks or breechings of all ulverized-coal plants shall be provided. Design of all pulverized-coal installa-ons shall be submitted to the Division of Smoke Regulation and Boiler Inspection r approval.

4. Oil

"(a) When oil is to be used as a fuel, the required combustion space for wer boilers up to 500 horsepower shall be determined on a basis of a maximum at liberation of 30,000 B. t. u. per cubic foot of combustion space per hour. r larger boilers special ruling shall be obtained from the Division of Smoke gulation and Boiler Inspection.

"(b) The required combustion space for heating boilers shall be determined the basis of a maximum heat liberation of 25,000 B. t. u. per cubic foot of mbustion space per hour. For specially designed boilers the combustion space all be determined according to the individual design of the equipment.

"(c) All oil burners installed shall be approved by the National Board of re Underwriters to burn the grade of oil which will be used. Design of all l-burner installations shall be submitted to the Division of Smoke Regulation d Boiler Inspection for approval.

"(d) Where oil of grade 5 or 6 is to be used, provision shall be made for ating and automatically maintaining the temperature of the oil at not less than 0° F. Electric preheaters shall be provided for starting when there is no eam available.

5. Net Load

"(a) "Net load" shall be construed to mean all radiation used for heating rposes, exclusive of piping, and reduced to the equivalent of direct cast-iron liation in a temperature of 70° F., which shall be calculated on a basis of) B. t. u. per square foot per hour for steam and 150 B. t. u. per square foot r hour for water.

"(b) Any generator, coil in firebox, indirect heater, or other device tached to boiler, used for heating water for domestic purposes, shall be in-uded in net load and shall be calculated in equivalent direct radiation in cordance with the rules of the Heating and Piping Contractors National Associa-on as shown in their Net Load Recommendations Manual.

"(c) The net-load capacity of heating boilers shall be the net-load recom-ndations of the Heating and Piping Contractors National Association, revised i amended to date.

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"(d) Or, where available, the net-load capacity may be obtained on the basis of the American Society of Heating and Ventilating Engineers Standard Code for Rating Steam Heating Boilers. Such boiler rating shall be determined as a result of tests made for the manufacturer by a disinterested party or laboratory acceptable to the Smoke Regulation Engineer.

"(e) The equivalent direct radiation (E. D. R.) rating of cast-iron boilers shall be obtained by adding not less than thirty-five (35) percent to the net-load rating; for steel heating boilers the E. D. R. ratings as determined by the Code of the Steel Heating Boiler Institute (S. H. B. I.) shall be used.

6. Clearance Around Boilers

"(a) All boilers or boiler settings shall have at least three (3) feet clear space on each side, in the rear, and in front of oil burner or stoker, except that in existing buildings this may be reduced by the Smoke Regulation Engineer, if after inspection it is found that it is impractical to obtain such clearances. In addition, sufficient space must be provided to remove boiler tubes.

"(b) Where replacement or additional installations of boilers are made in existing buildings the minimum height of the boiler room shall be such as to provide not less than six (6) inches clear space above the highest point of any valve or other fitting when it is at maximum opening or stems and levers at their greatest height. In new or reconstructed buildings not less than seven (7) feet shall be provided between the top of the boiler proper and the ceiling or other obstruction, except that in single installations of self-contained boilers a minimum clearance of at least three (3) feet may be provided between the highest point of any valve or fitting and the ceiling or other obstruction.

7. Stacks

"(a) Power boilers having more than 120 square feet of boiler heating surface shall have a stack of sufficient height or shall have an induced-draft fan to give a minimum draft of 0.20 inch of water over the fire in the furnace under normal working conditions. No such stack shall be less than 45 feet above the ground line, unless gas is used as fuel.

"(b) Size and height of stacks for power boilers shall be based on approved chimney practice, taking into consideration draft losses in boiler and breeching.

"(c) Heating plants having boilers with a net-load rating of more than 1,200 square feet of steam radiation or 1,800 square feet of water radiation shall have a minimum draft of 0.15 inch of water over the fire in the furnace under peak-load conditions.

"(d) With the exception of gas-fired boilers or heaters, the following table shall in general be used as a guide. Stack sizes are inside dimensions, and plans should be so marked. The sizes given are for one boiler and are minimum.

"(e) Where boiler capacity is in excess of ratings shown in table, stack shall be figured on the same basis as for power boilers.

"(f) If it is impractical to obtain the height of stack as indicated an induced-draft fan may be used, subject to the approval of the Division of Smoke Regulation and Boiler Inspection, provided the discharge from the stack will not become a nuisance to neighboring buildings.

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"(g) The provisions of the act of June 1, 1910, 36 Stat. 452, as to stacks shall continue in full force and effect.

Stack table for heating boilers

Rectangular flue lining			Standard flue lining	Round flue	Minimum 1/
Boiler rating, square feet of radiation		Actual inside dimensions		Actual inside diameter	Height above grate
Steam	Water				
		Inches	Inches	Inches	Feet
To 450	To 720	8 x 12	8 x 13	10	35
800	1,280	12 x 12	13 x 13	12	35
1,000	1,600	12 x 16	13 x 18	15	40
1,500	2,400	16 x 16	18 x 18	18	40
2,000	3,200	18 x 18	20 x 20	18	45
2,500	4,000	17 x 21	20 x 24	20	50
3,000	4,800	21 x 21	24 x 24	22	55
3,500	5,600	21 x 21	24 x 24	22	55
4,000	6,400	22 x 22	-------	24	60
5,000	8,000	24 x 24	-------	26	60
6,000	9,600	26 x 26	-------	28	65
7,000	11,200	26 x 28	-------	28	65
8,000	12,800	28 x 28	-------	30	70
9,000	------	30 x 30	-------	32	70
10,000	------	32 x 32	-------	34	75
12,500	------	34 x 34	-------	38	75
15,000	------	36 x 36	-------	40	80
17,500	------	38 x 38	-------	42	85
20,000	------	40 x 40	-------	44	90
25,000	------	42 x 42	-------	46	100

1/ Height must be increased if breeching is more than ten (10) feet long or has more than one bend.

NOTE. - For each additional boiler add not less than seventy-five (75) percent of the area and ten (10) feet to the height as given in table.

"(h) The inside walls of each stack shall be smoketight, vertical, free rom offsets or constrictions, and have a clean-out opening with a tightly fitted oor. All stacks shall conform to requirements of the building code.

"(i) The top of any stack shall extend sufficiently above the roof of the ilding of which it is a part, and shall extend above or be far enough away from y nearby building to prevent down drafts or the creation of a nuisance by the ischarge of smoke or the gases of combustion.

"(j) Where an existing stack is so located that it will constitute a isance to the occupants of a building about to be built, the owner of the new ilding shall be required either to extend the existing stack or make other ovisions to meet the approval of the Division of Smoke Regulation and Boiler spection.

" (k) Boilers or furnaces located in separate rooms or buildings shall each ve a separate stack or flue lining in the stack.

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"(l) The tops of boiler stacks shall not be covered with caps or screens.

"(m) Stacks shall be as nearly square or round as possible. Where the stack is rectangular or oval in cross section, the greatest dimension shall not exceed twice the smallest.

8. Breechings

"(a) Breechings shall be as nearly square or round as possible. Where the breeching is rectangular or oval in cross section the greatest dimension shall not exceed twice the smallest. The minimum radius of all bends shall not be less than the width of breeching at point where bend occurs.

"(b) Breeching shall be as short and straight and free from bends or curves drops below horizontal, or other restrictions as possible.

"(c) Where separate hot-water heater is to be provided the breeching may be connected directly to the stack but below the entrance of the boiler breeching.

"(d) Every breeching shall be provided with sufficient clean-out openings having tightly fitted doors and of sufficient size so that all parts of breechi may be easily cleaned.

"(e) The draft loss in the breeching shall be taken into consideration in the design of the boiler plant and stack.

"(f) A lay-out of breeching must accompany application for permit.

9. Air to Boiler Rooms

"(a) Each boiler or furnace room shall have an opening or openings to the external air to provide sufficient air for proper combustion, as may be determined by the Smoke Regulation Engineer.

10. Smoke Indicators

"(a) All new fuel-burning plants having more than 300 square feet of boile heating surface or its equivalent shall be equipped with smoke indicators, mir or similar devices, approved by the Division of Smoke Regulation and Boiler In spection, to enable the firemen easily to observe smoke conditions from the boiler room at all times, unless the top of the stack is readily visible to th firemen. This provision shall apply to all existing boilers when new oil burners or mechanical stokers are installed. Where oil of grade 5 or 6 is to be used a smoke alarm shall be provided.

11. Vertical Boilers

"(a) Vertical fire-tube boilers shall be installed only upon entering int a fuel agreement unless such boilers are equipped with oil or gas burners. Or one boiler of this type containing not more than 250 square feet of heating surface shall be permitted in a plant.

12. Scotch Marine Boilers

"(a) Scotch marine boilers shall be installed only upon entering into a fuel agreement unless such boilers are equipped with oil or gas burners. If equipped with oil burner, a dutch oven shall be provided. An underfeed stoke

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ay be permitted where it is specially designed for this type of boiler. When and-fired only one boiler of this type containing not more than 250 square feet f heating surface shall be permitted in a plant.

13. Warm-Air Furnaces

"(a) Warm-air furnaces having 7 square feet or more of grate surface shall e equipped with underfeed stoker, oil or gas burner, approved by the Division f Smoke Regulation and Boiler Inspection, unless owner of building or plant igns a fuel agreement.

"(b) Warm-air furnaces having less than 7 square feet of grate surface shall rn coke, anthracite, or low-volatile coal, or shall be equipped with underfeed oker, oil or gas burner, approved by the Division of Smoke Regulation and iler Inspection.

"(c) Heating plants having warm-air furnaces with a total of 7 square feet more of grate surface shall have a stack of sufficient height to give a nimum draft of 0.15 inch of water over the fire in the furnace under normal rking conditions.

14. Water Heaters

"(a) Water heaters shall burn coke or anthracite or shall be equipped with derfeed stoker, gas or oil burner.

"(b) When a heating boiler is equipped with an underfeed stoker and a hand-red water heater is used, a separate bin shall be provided for fuel for the ater.

"(c) Hot-water heaters used in connection with a tank of less than 100 llons capacity shall not require an installation permit.

15. Incinerators

"(a) Incinerators shall be built in accordance with the incinerator code d shall have a stack separate from that of the boiler or furnace.

"(b) The stack shall terminate in a substantially constructed spark rester made so as to project above the top of the stack and having openings t larger than one-fourth inch.

16. Portable Boilers and Contractors' Equipment

"(a) After January 1, 1937, no person or corporation shall operate any rtable boiler, steam shovel, portable crane, derrick, hoist, road roller, tar ttle, asphalt kettle, or any other similar portable equipment capable of itting smoke until he shall have signed a fuel agreement and obtained a permit om the Division of Smoke Regulation and Boiler Inspection. All such existing uipment shall use coke or anthracite, or be equipped with oil burners approved the Division of Smoke Regulation and Boiler Inspection.

"(b) The Division of Smoke Regulation and Boiler Inspection shall have thority to attach identification tags to all such equipment.

"(c) After January 1, 1938, equipment of the above-mentioned type shall be erated by internal-combustion engine or electric motor; tar and asphalt ttles shall use only oil burners.

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17. Process Furnaces, Stills, and Other Apparatus

"(a) Detailed description and drawings of any furnace, still, or other apparatus, capable of causing smoke, cinders, dust, gas, or odors, showing the design, amount, and kind of fuel to be used, etc., shall be submitted to the Division of Smoke Regulation and Boiler Inspection for approval.

18. Rubbish Burning

"(a) No person constructing, tearing down, or wrecking any building or structure shall burn tar paper, refuse, or rubbish in an open fire at the site.
"(b) No person shall burn any garbage, refuse, rubbish, or other combustible material in an open fire.

SECTION V. - PENALTY

1. Failure to Comply

"(a) Failure to comply with any of these rules and regulations or any provision thereof, shall subject such person or persons to the penalty prescribed by the act of Congress approved August 15, 1935.
"(b) SEC. 3. *** Any person convicted of violating this act or any regulation of the Commissioners made hereunder shall be punished by a fine not to exceed $500 for each and every such offense."

The place where smoke is actually abated is, of course, at each individual plant. Whether or not a plant owner is subject to ordinances and regulations he may wish to maintain a clean stack for the sake of the neighborhood and the monetary saving resulting from more complete combustion. If black or carbon smoke is produced to any great extent in the furnace, it is very difficult to burn and usually goes out the stack. Only very expensive equipment, such as the Cottrell precipitator, can prevent it from going into the atmosphere; therefore it should not be so produced in the furnace. To burn a fuel completely it is necessary to keep it hot and to give it air and enough room in which to burn. The flame should not be chilled below satisfactory ignition by any cold surface. There is a load limit for each furnace above which the unit should not be operated. A flame usually can be shortened by the use of steam-air jets. Properly placed, these increase the turbulence in the furnace, causing the oxygen of the air to reach the combustible particles quicker. In many furnaces such jets may be placed at the front wall near the corners of the setting and aimed slightly downward and diagonally across the furnace to the opposite corner. These jets may be simply made from ordinary pipe and fittings. As an example a 2- or 3-inch pipe for the air may be used in the furnace wall; concentrically inside is placed a 1/4-inch pipe for the steam, ending in a plug in which is drilled a 1/8-inch hole; the plug end is placed a foot or more back of the air-pipe outlet into the furnace (7). The use of steam-air jets has been the most practical method of helping many smoke-abatement problems. Some regulations require their use on all overfeed stokers. Objections have been raised due to their use of steam and their noise. The following table is taken from a paper by Lannert (8).

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Saturated steam discharged through nozzles (pounds per minute)

Diameter at smallest section, inch	Steam pressure, pounds per square inch gage												
	40	50	60	70	80	90	100	110	115	125	150	175	200
1/16	0.15	0.17	0.2	0.22	0.25	0.27	0.30	0.32	0.35	0.37	0.43	0.5	0.56
3/32	.3	.4	.5	.5	.6	.6	.7	.7	.8	.8	1.0	1.1	1.3
1/8	.6	.7	.8	.9	1.0	1.1	1.2	1.3	1.4	1.5	1.7	2.0	2.3
5/32	.9	1.1	1.3	1.4	1.6	1.7	1.9	2.0	2.2	2.3	2.7	3.1	3.5
3/16	1.3	1.6	1.8	2.0	2.2	2.5	2.7	3.0	3.1	3.3	3.9	4.5	5.1

For example, at 100 pounds steam pressure at the nozzles two 1/8-inch jets ısed continuously, which is seldom necessary, would take about 1.6 percent of the ıteam produced by a 300-horsepower boiler running at rating. The improvement in he combustion, however, ordinarily more than compensates for this loss. If the ir inlets to the jets are open to the air at the boiler front, much noise is roduced, and the operators are not apt to use them. However, if the air is ipe up from the stoker wind box, or taken from air channels in the settings, he noise disappears. Bringing the air through the setting also preheats the ir to some extent.

Changes in the furnace arrangement may sometimes be made at low cost. For xample, in the common horizontal return tubular setting, an arch thrown back of he bridge wall will cause the gases to travel away from the shell and better se the combustion space for burning. Engineers working on changes in old equip- ent or on new designs will find many pointers in the city regulations cited reviously. Where much change in design is necessary it is usually best to call n an experienced man on such problems.

Fly ash, unlike carbon smoke, is continually leaving the furnace even under ıe best conditions. The amount varies greatly with the load or the pounds of oal burned per square foot of grate area. For example, on one underfeed installa- ion, increasing the fuel rate per square foot of grate area about three-fourths, r from 23.0 to 40.5 pounds, raised the amount of fly ash, expressed as a per- entage of the weight of the total coal fired, about 3.8 times, or from 0.73 to .80 percent; the actual weight of the fly ash leaving the boiler per hour in- reased about 6.8 times, or from 82.4 to 556.9 pounds (9). Much of the fly ash, articularly the larger sizes, may never reach the stack outlet. An appreciable ercentage can be caught in various passes in the boiler and in properly placed inder traps. At any place where the velocity of the gases drops some fly ash ill be deposited, as the speed of fall of the heavier particles is enough to eparate them from the gases. Collecting-hopper arrangements may be provided in uch chambers and passes in the boiler; some well-designed installations provide ı ejector that returns fly ash to the combustion chamber for further burning. mple forms of baffle-type cinder catchers may be installed in the breeching and rrangements made to dump them regularly; where more can be expended for fly ash moval various more-complicated forms of cinder catchers are available.

Where too much fly ash is permitted to accumulate in one place, such as ong the bottom of the breeching, it may lift suddenly and go out the stack,

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creating an immediate nuisance. Keeping all passages clean is a great help. Fly ash will settle at the base of the stack; the amount will depend upon the velocity of gases up the stack. Air openings at the base of the stack or below the breeching entrance may prevent considerable settling of fly ash. Opening the door at the base of the stack usually causes accumulated fly ash to lift. Where this is necessary to clean out fly ash the use of water will help. A simple circular-pipe water spray may be installed at the base of the stack below the point where the breeching enters, and the fly ash may be wet down just before it is removed. Sometimes a simply designed spray is installed above the breeching entrance for intermittent use when the boiler tubes are blown. Such a spray lowers the temperature of the flue gases and will thereby lower the draft available from the stack. The water picks up sulfurous gases and becomes acidified, and considerable water vapor goes into the stack gases. Various corrosion problems may develop if the water is allowed to flow continuously. Only expensive specially developed spray equipment should be so used. However, for intermittent operation at rather long time intervals, such equipment is kept dry by the flue gases most of the time and has given satisfactory service for help in tube blowing.

Regardless of well-planned equipment, the project of successful smoke abatement ends with human factors. The operators must be trained in handling their particular equipment and enthused with the idea of abating smoke and fly ash. Devices should be installed so that the operator can know at all times the smoke condition of the stack. Perhaps the simplest device is the ordinary mirror so placed that the top of the stack is always visible. Periscopes of various types may be used. Instruments are available on the market that record smoke emission, throw colored lights on and off, and ring bells. One instrument that is very effective from the standpoint of getting quick action from the operator is a raucous horn which blows when the smoke density passes a chosen point. Organized periodical meetings of chief engineers and operators, at which several of them tell their experiences in improving conditions, will prove very helpful in keeping up enthusiasm.

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